



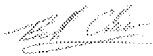
UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON D.C., 20460

OFFICE OF CHEMICAL SAFETY
AND POLLUTION PREVENTION

October 26, 2020


MEMORANDUM

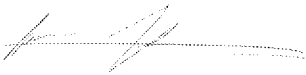
SUBJECT: Dicamba Use on Genetically Modified Dicamba-Tolerant (DT) Cotton and Soybean: Incidents and Impacts to Users and Non-Users from Proposed Registrations (PC# 100094, 128931)

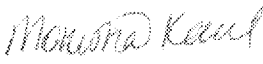
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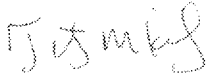
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SUMMARY

This document provides information to support registration decisions on dicamba products for use on genetically modified dicamba-tolerant (DT) cotton and soybean (also referred to as over-the-top (OTT) dicamba applications/products). It builds on two related documents describing the benefits of dicamba products on DT cotton and soybean (Orlowski and Kells, 2020a; 2020b). BEAD also reviewed and evaluated recent incidents from OTT use of dicamba and the impact of these incidents on non-users; and analyzed impacts from potential control measures on users.

Dicamba is the second auxin herbicide (after 2,4-D) registered for OTT application to herbicide tolerant cotton and the third auxin herbicide (after 2,4-D and 2,4-DB), for OTT application to herbicide tolerant soybean. BEAD's review of benefits concludes that the availability of DT cotton and DT soybean gives many growers increased flexibility in their choice of seed varieties. Growers using DT seed have the option to use dicamba for preemergence and postemergence use as a cost-effective way to control herbicide-resistant broadleaf weed species, and as a tool to delay the further development of herbicide resistance (Orlowski and Kells, 2020a; 2020b).

Dicamba-tolerant crops have the greatest utility as a resistance management measure to control glyphosate-resistant weeds, similar to other herbicide tolerant systems and their herbicide partners. Glyphosate resistance is a concern; when glyphosate resistant weeds were present in soybeans, there was a reduction of 14% in total returns per planted acre (Livingston et al., 2015). Since the original 2016 registration of OTT dicamba products, the number of incidents related to lack of product performance of dicamba reported to the Agency has increased; resistance has been confirmed in three weed species in multiple states; and additional weed species are being investigated now for potential dicamba resistance. As additional weed species develop resistance to dicamba, as has happened with other herbicides, this technology will become less useful to growers with herbicide-resistant weeds.

Concomitant with the registration and grower adoption of the OTT dicamba products, large numbers of incidents of damage from offsite movement have been reported. The number of offsite incidents reported to the EPA were compared with the incidents reported in USDA's 2018 Soybean Agricultural Resource Management Survey (ARMS). This comparison showed incidents are being underreported to EPA. Based on this information, the magnitude of underreporting appears to be approximately 25-fold (i.e., one incident is reported to the Agency for 25 incidents that are being reported to USDA).

The ARMS also examined the timing of applications of dicamba to cotton in 2019 and soybean in 2018. The results showed that the OTT products were being used on DT soybean and cotton as intended, with most of the applications taking place after planting. The survey showed that the more volatile dicamba products not intended for use on DT crops (non-OTT products) were also used on DT crops after planting; about 53% of acre treatments with non-OTT products on DT soybeans (2018 soybean) and 59% of acre treatments on DT cotton (2019 cotton) were being made after planting. Because these non-OTT products are not registered for this application

timing, these applications are misuse of these non-OTT products. Misuse is handled through enforcement actions.

The impacts of offsite movement of dicamba from OTT applications to non-users can be substantial. High value crops may suffer yield and quality losses, organic growers could lose organic certification, research and crop breeding programs could be disrupted, and plantings in residential areas (e.g., home gardens) and landscapes could be damaged. State lead agencies, through AAPCO, have reported budget shortfalls and other resource constraints due to the number of dicamba-related incidents requiring them to divert or reallocate resources to investigate.

New technologies such as the dicamba-tolerant system (dicamba-tolerant seed trait plus use of dicamba after crop emergence) can often be controversial. Offsite movement of dicamba from products registered for use on DT crops that injures adjacent crops has resulted in conflict between neighbors. Injured parties may make reports to state authorities or sue for damages. Complaints and lawsuits may, in turn, spark or further escalate social impacts.

The registration of these OTT dicamba products may reduce the misuse of dicamba products not intended for dicamba tolerant crops (e.g., more volatile products). If these OTT dicamba products were not available, the DT seed, not subject to regulation under FIFRA, along with more volatile formulations of dicamba products, will still be on the market, and a temptation to misuse the more volatile formulations would exist. BEAD expects that social impacts would likely continue even if registrations for dicamba products for use on DT crops were not available.

In making regulatory decisions under FIFRA, the Agency considers both benefits and risks when deciding whether a product can be registered. EPA has identified a number of control measures and restrictions to address the potential for adverse effects related to spray drift and volatile emissions. We expect that the ease of compliance with the label restrictions will likely vary by the individual measure. Key determinants include the training and integrity of the applicator, the availability and cost of required spray adjuvants (e.g., pH buffering agents and drift reducing agents), the extent of weed pressure, whether weather conditions permit planned applications before cutoff dates, and how well buffer requirements can be incorporated in the farming operation. The complexity of the buffers (varying distances dependent on location [county], wind direction, adjacent sensitive crops or other plants), along with the complexity of the other control measures taken as a whole, may correlate with the ease of compliance.

While control measures are designed to address risk of offsite movement, several of the control measures on the draft labeling will increase applicator/grower costs as compared to the costs of using the OTT products available in 2019 and 2020, as well as other herbicide programs, and may prevent some growers from fully utilizing the technology. Cutoff dates may prevent some growers from making timely applications by preventing later season OTT applications. Mandatory use of adjuvants (i.e., pH buffering agents and drift reducing agents) will increase per-acre costs. Increases in buffer distances may be difficult for growers to incorporate into their

production practices, will complicate weed control adjacent to the field borders, and may discourage growers from implementing management measures (Hartzler, 2018). Having separate product labels for just DT soybean and DT cotton may simplify use for users and improve compliance.

Hooded sprayers, if utilized, may benefit growers by reducing the buffer distance to address offsite movement, but would increase the time needed to make applications because these sprayers require reduced tractor speeds. The number of growers likely to adopt hooded sprayers is limited at this time because 1) these sprayers are rarely used in cotton and soybean production, 2) manufacturers currently produce only 2,000 hooded sprayer units per year, and 3) self-constructed hooded sprayers would not be permitted unless the sprayer is tested by a third-party and found to meet the performance standard.

These control measures should benefit non-users by addressing offsite movement. However, impacts to non-users of OTT dicamba products may still occur, if misuse occurs.

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I. INTRODUCTION

This document provides information to support registration decisions on dicamba products for use on cotton and soybean that have been genetically modified to be tolerant to dicamba (DT crops). These products may be applied preemergence to the crop as well as postemergence to the crop using over-the-top (OTT) applications. Topics covered in this document include incidents (both plant damage resulting from offsite movement and non-performance of the product), impacts to growers from implementing possible control measures and impacts to non-users from the registration of these products. A quantitative assessment of benefits of dicamba products on dicamba-tolerant (DT) cotton and soybean are summarized in two separate documents (Orlowski and Kells, 2020a; 2020b).

In this document the term “impact” is being used for both users and non-users. First, users who grow soybean and cotton and use the OTT products considered in this regulatory action will have to implement control measures and may experience impacts such as yield and quality loss, and increased costs of production. Second, non-users may experience impacts from crop injury or increased costs resulting from offsite movement of dicamba if offsite movement occurs as a result of the approval of this product.

Dicamba was first registered in the United States in 1967 and has been widely used as an herbicide on agricultural crops, fallow, turfgrass, and pastures and rangeland. It is a synthetic auxin that affects cell wall plasticity and nucleic acid metabolism and is classified by the Weed Science Society of America as a Group 4 Mechanism of Action (MOA). Dicamba is used for the control of emerged broadleaf weeds and provides some residual control of germinating weeds (WSSA, 2014).

Dicamba has two properties that have complicated its use as an herbicide. First, many crops (e.g., most fruit and vegetables, and non-DT cotton and soybean) and many desirable non-crop plant species (e.g., residential ornamentals and trees) are sensitive to dicamba and can be damaged by very low levels of dicamba (Culpepper et al., 2017). By 1971, just five years after the initial registration for a dicamba pesticide product, some agricultural extension literature was discouraging the use of dicamba due to the risk of offsite movement into adjacent fields of sensitive crops (Hartzler, 2017).

Second, dicamba is volatile (Burnside and Lavy, 1966) and is prone to move off the site of application. Behrens and Leuschen (1979) investigated factors influencing the volatility of dicamba, including temperature, rainfall following application, application surface (soil, leaf type), and formulation. They found that volatilization of dicamba formulations varied, with the acid being most volatile and the inorganic salts being less so. Since then, different salts of dicamba have been registered that have lower volatility than the first dicamba product (Banvel™, dimethylamine salt). These include Banvel II™ (sodium salt) registered in 1981 and Clarity™ (diglycolamine salt) in 1990 (Hartzler, 2017).

Beginning in 2016, EPA registered three dicamba products with significantly lower volatility for OTT application to DT cotton and soybean – Xtendimax™ with VaporGrip™ Technology (diglycolamine salt; Bayer; EPA Reg. No. 524-617), Fexapan™ with VaporGrip™ Technology (diglycolamine salt; Corteva; 352-913) and Engenia™ (bis aminopropyl methylamine or BAPMA salt; BASF; 7969-345) (USEPA 2016a, 2016b, 2017). In April 2019 Tavium™ with VaporGrip™ (diglycolamine salt co-formulated with s-metolachlor; Syngenta; 100-1623) was registered. This product provides two modes of action for resistance management. Because it contains s-metolachlor, the pre-harvest interval (PHI) is 100 days for cotton and 90 days for soybean. This long PHI requires Tavium™ with VaporGrip™ to be applied early in the growing season when offsite movement from volatility is less likely because of lower temperatures.

The USDA reviews and deregulates crops with genetically modified traits. In 2015, the USDA announced the deregulation of cotton and soybean seed with a dicamba resistant trait (Firko, 2015a, 2015b), prior to the registration of these OTT products. The traited cotton was commercialized in 2015 and the traited soybean was commercialized in 2016 and adoption increased each year following commercialization (Kynetec, 2019). During the 2015 and 2016 growing seasons, there were no registered dicamba products for OTT application to these crops.

Based on pesticide incident investigations reported by state lead agencies, older and more volatile formulations of dicamba were used illegally over-the-top on these dicamba-tolerant crops in 2016. These applications resulted in a number of offsite damage incidents to sensitive non-dicamba tolerant soybean and cotton, as well as peaches, tomatoes, cantaloupes, watermelons, rice, cotton, peas, peanuts, and alfalfa (EPA, 2016c). While there were no incidents reported in 2015, recently publicly released court findings indicate registrants were aware that illegal dicamba applications occurred in 2015 on DT cotton (Carey, 2016); however, these were not reported to the Agency.

EPA registered the three OTT dicamba products for use on genetically engineered (GE) DT cotton in late 2016 and in early 2017 for GE DT soybean, and the registrations were extended by the Agency on October 31, 2018. The extended registrations included additional labeling restrictions, and requirements imposed by the terms and conditions of the registration (e.g., required enhanced reporting and new data submissions). The registrations of these three products were subsequently vacated on June 3, 2020 by the United States Court of Appeals for the Ninth Circuit (2020). On April 5, 2019, Tavium™ was also registered on these DT crops but was not part of the vacatur. The current time-limited registration for Tavium™ extends until December 20, 2020.

The large number of incidents resulting from offsite movement of the dicamba OTT products registered for use on DT crops prompted the Agency to reassess the risks posed by the use of these products at multiple points since the initial registration in 2016. Each reassessment resulted in label modifications (2017 and 2018) intended to address offsite movement. Incidents continued to occur in 2019 and 2020 (Miller, 2020).

Currently, the Agency is considering registration applications for dicamba products (Xtendimax™, Engenia™, and Tavium™) for use prior to emergence of the crop and over the top of DT cotton and DT soybean crop after emergence.

II. PUBLIC LETTERS RECEIVED

While there was no public comment period for the 2018 or pending 2020 dicamba registration decisions, the Agency has received dozens of letters concerning the pending dicamba registrations for use with DT cotton and soybean. Information from the submitted letters are incorporated, as appropriate, in this memorandum and the benefits memoranda for cotton and soybean (Orlowski and Kells, 2020a, 2020b). While these memorandum take into consideration all comments known to have been received, because there was not a formal comment period for this dicamba decision and no finite cut-off date, it is possible that comments received close to the date of this memorandum have not reached the authors.

Several letters indicated that growers need as many tools as possible and that dicamba for use in DT cotton and soybean is important to combat troublesome weeds (Palmer amaranth). Some of the letters provided information about the adoption rate of this technology as an indicator of importance to growers; how regulation can hamper the development of new technologies to help growers control weeds; how timely decision is needed to help inform seed purchases for the 2021 growing season; and offers suggestions for the Agency when considering control measures intended to address offsite movement. As of October 25, 2020, examples of letters received include those from *agricultural coalitions* from the states of: Alabama (2020), Kansas (2020), Nebraska (2020), Georgia (2020), Virginia (2020) and Mississippi (2020); *seed dealers/Co-Ops*: LG Seeds (2020), MO-AG (2020), Wilbur-Ellis (2020), Proseed (2020); Beck's Hybrids (2020a; 2020b), Latham Hi-Tech Seeds; *commodity groups*: National Cotton Council (NCC) (2020a; 2020b), American Soybean Association (ASA) (2020), Southern Crop Protection Association (SCPA); registrant representatives: Crop Life America, Georgia Cotton Commission, Plains Cotton Growers, ASA and NCC (2020), American Seed Trade Association (ASTA, 2020a; 2020b); *individual growers*: Frese (2020), Jacobson (2020), Janssen (2020) and Smither (2020); *private citizens*: Dintelmann (2020), Horn (2020); *academics*: (Hartzler, 2020a); *governmental entities*: Iowa Department of Agriculture and Land Stewardship (2020), Kansas Department of Agriculture (2020), Pennsylvania Department of Agriculture (2020), the governor of Nebraska (Ricketts, 2020), the U.S. House of Representatives Committee of Agriculture (2020), and Members of Congress (2020) and *trade organizations*: the National Association of State Department of Agriculture (NASDA) (2020); and NASDA and American Association of Pest Control Officials (AAPCO) (2020).

Another set of letters from stakeholders provided varying levels of details describing incidents and views on underreporting of incidents. These letters describe damage to vineyards, non-DT soybean, and numerous species of trees and other broadleaf herbaceous plants. These incidents

were documented on small farms, residential areas, public lands (e.g., parks, natural areas, wildlife refuges), industrial landscapes (e.g., cemeteries, business store fronts) and roadsides. Additionally, the issue of “right to farm” was raised (i.e., growers have the right to grow crops without concern for losing an organic or sensitive crop because of offsite movement of dicamba). In addition to concerns about effects to single-season crops, letters also cited concerns about long-term economic impacts of dicamba damage specific to orchards and vineyards. These letters were received from a *coalition* for specialty crop growers (Save our Crops Coalition, 2020); a *non-dicamba-tolerant soybean grower/private citizen*: Nelms (2020); a *small vineyard owner/private citizen*: Poteet (2020); *crop consultants*: Baldwin (2020a; 2020b), Nesse (2020); and *non-governmental organizations*: Audubon Arkansas (2020), National Wildlife Federation (2020), Prairie Rivers Network (2020), The Land Connection (2020), and Center of Food Safety (2020a; 2020b); and a *trade organization*: American Association of Pest Control Officials (AAPCO, 2020a).

. In addition to these letters, there were numerous communications with several academics that are incorporated throughout this memorandum; however, this communication is not part of this section: Public Letters Received. These are cited as personal communication in this document.

III. CONCLUSIONS FROM PREVIOUS BEAD ASSESMENTS OF BENEFITS FOR OTT DICMBA REGISTRATIONS

2016

In 2016, BEAD only considered the claims made by the registrant and found that postemergence OTT dicamba provided DT soybean and cotton growers with another active ingredient to manage difficult to control broadleaf weeds during the crop growing season, especially glyphosate-resistant weeds (Yourman and Chism, 2016). Prior to this registration, dicamba could only be used as a preplant broadcast treatment to control emerged weeds in cotton or soybean. The benefits assessment also discussed potential impacts from dicamba applications. The assessment (Yourman and Chism, 2016) noted that “an increased number of applications of dicamba to large acreage may increase the likelihood of offsite damage to surrounding sensitive plants through drift and/or volatility....Mitigation through label restrictions of wind speed, droplet size, buffers, etc. should reduce the chance of off-[target] damage.”

2018

In 2018, BEAD (USEPA, 2018) again found that the main benefit of postemergence OTT dicamba use was that it provided another active ingredient to manage difficult to control broadleaf weeds during the growing season. It could provide a long-term benefit as a tool to delay the evolution of resistance of other herbicides when used as part of a season-long weed management program that includes preemergence (residual) and postemergence (foliar) herbicides (along with rotations between different mechanisms of action). The document

pointed out that there are effective alternative weed control programs available to growers. As is the case with other genetically modified herbicide tolerant varieties (i.e., glyphosate, glufosinate, and 2,4-D), the use of the OTT herbicide partner may reduce the management complexity associated with pre-selecting an effective postemergence herbicide with little to no risk of damage to the treated crop. However, repeated uses of a single active ingredient/mode of action to control Palmer amaranth or other difficult to control weeds within a season or in consecutive years is likely to increase selection pressure for the evolution of dicamba-resistant weeds.

2019

In 2019, the Agency registered Tavium Plus Vaporgrip Technology containing a combination of dicamba and S-metolachlor for over-the-top use on dicamba-tolerant cotton and soybean (EPA Registration Number 100-1623). This combination of two active ingredients was previously approved as a tank mix partner, and as such, was already used over the top on cotton and soybean. The Agency found no unique benefits to the product not discussed in the 2018 assessment for the other dicamba products for use on DT crops (Tindall, 2019).

2020

The Agency reviewed the benefits of dicamba in cotton and in soybean (Orlowski and Kells, 2020a and 2020b); what follows is a summary of the findings of those documents. When looking at the average usage between 2017 and 2018, growers used dicamba (including both dicamba products for use on DT crops and those not approved for use on DT crops) on 43% of all U.S. cotton acres, including 17% of all U.S. cotton acres prior to crop emergence and 34% of all U.S. cotton acres after crop emergence. Two applications were made on 44% of cotton acres treated postemergence with dicamba. Growers used dicamba on 21% of all U.S. soybean acres, including 8% of all U.S. soybean acres prior to crop emergence and 17% of all U.S. soybean acres after crop emergence. Two applications were made on 8% of soybean acres treated postemergence with dicamba. Postemergence dicamba in cotton production is primarily used to target herbicide-resistant Palmer amaranth and redroot pigweed. In soybean, dicamba is primarily used to target herbicide-resistant Palmer amaranth, waterhemp, kochia, ragweed, and marehail. In addition to these weeds, dicamba is also effective at controlling a large range of other broadleaf weed species.

There are effective alternative weed control programs currently available for the control of problematic broadleaf weeds in cotton or soybean. When considering the different herbicide-tolerant (HT) crop varieties and non-HT varieties, for cotton there are 20 different active ingredients within 12 MOAs that provide Palmer amaranth control for cotton, and for soybean there are 26 active ingredients within 10 MOAs that provide Palmer amaranth control (for a detailed description of other alternatives, see USEPA, 2018). However, the number of postemergence herbicide options for the control of some problematic broadleaf weeds may not be appropriate for all users. This is especially true for growers facing weed populations with resistance to glyphosate (Weed Science Society of America [WSSA] Group 9 herbicide), ALS

(acetolactate synthase) inhibitor herbicides (WSSA Group 2,) and PPO (protoporphyrinogen oxidase) inhibitor herbicides (WSSA group 14). The registration of dicamba in DT cotton or soybean would give growers additional flexibility in choosing varieties for managing herbicide-resistant weed populations, thereby prolonging the effectiveness of currently available control options for herbicide-resistant weed species. However, the development of dicamba-resistant weed populations has the possibility to reduce the benefits growers obtain from this technology in some areas.

In soybean, a postemergence dicamba-based herbicide program may be somewhat less expensive than alternative herbicide programs. Relative to some herbicide programs (e.g., a 2,4-D based program), a postemergence dicamba program may reduce grower costs by \$12-\$14 per acre (4%-7% of grower net operating revenue, depending on region), not including the cost of adjuvants, but growers who chose a glufosinate program could see similar costs to the postemergence dicamba program. In cotton, relative to other alternative herbicide programs, postemergence dicamba may reduce grower costs by \$8-\$14 per acre (5%-10% of grower net operating revenue), not including the cost of adjuvants. Seed costs and rebates offered by seed and chemical manufacturers can affect the overall cost of the herbicide program, as can the additional costs of adjuvants. . Information on how the cost of adjuvants may impact the price of a postemergence dicamba-based program is available below in the section *pH Buffering Adjuvants and Drift Reducing Adjuvants*.

Regardless if it is a cotton or soybean field, if a grower has dicamba-resistant Palmer amaranth or waterhemp that exhibits decreased susceptibility to dicamba, additional herbicides applications will likely be necessary to achieve adequate weed control, increasing the cost of the postemergence dicamba program. Control measures, discussed in Section IV, may also impinge on the benefits of these products.

While the greatest value of dicamba products for use on DT crops is use after crop emergence, they also have value in DT crops prior to crop emergence. Currently registered dicamba formulations not approved for use on DT crops include a preplant restriction of a specified number of days and/or rainfall between dicamba application and planting to avoid injury to cotton or soybean. Since DT crops are highly tolerant of dicamba and the proposed registrations do not include preplant plant restrictions (i.e., preplant, at plant, after plant but before emergence), the ability to apply dicamba immediately before planting through emergence increases the flexibility for preemergence dicamba use, especially given that the older formulations of dicamba do not permit this use pattern.

Overall, BEAD concludes that the registration of dicamba for preemergence and postemergence use in DT crops gives many growers increased flexibility in their choice of seed varieties. Growers using DT seed have the option to use dicamba as a cost-effective way to control problematic herbicide-resistant broadleaf weed species, and as an additional tool to delay the further development of herbicide resistance.

For more information, see *Assessment of the Benefits of Dicamba Use in Genetically Modified, Dicamba Tolerant Cotton Production* and *Assessment of the Benefits of Dicamba Use in Genetically Modified, Dicamba Tolerant Soybean Production* in the docket (Orlowski and Kells, 2020a and 2020b).

IV. IMPACTS TO USERS FROM CONTROL MEASURES

This section describes the impacts to dicamba users from possible risk control options that may influence how and when the herbicide can be applied and therefore the benefits to the user of this herbicide.

State Restrictions

During 2019 and 2020, some states added restrictions in addition to the federal label changes made in 2018 on the use of OTT dicamba to help address offsite movement. For example, in 2020 Arkansas required a May 25th cutoff date (date by which dicamba could no longer be used OTT on soybean and cotton) and a requirement to not tank mix dicamba with glyphosate (Unglesbee, 2020). Illinois, Indiana, and Minnesota implemented a June 20th cutoff date for soybean while North and South Dakota have a June 30th cutoff date for soybean (Unglesbee, 2020). BEAD does not have state level incident data to determine the impacts of these state level restrictions but when viewed on a national level a May 25th cutoff date would be before any incidents occur, a June 20th cutoff date would be before 70% of incidents occur, and a June 30th cutoff date would be before 60% of the incidents occur (see Dicamba Related Incidents Reported to the Agency and Figure 2).

Application Cutoff (Calendar Date and Growth Stage)

An application timing restriction prohibiting applying later than a specific calendar date (cutoff date) or plant growth stage could potentially address offsite movement by prohibiting dicamba applications. Two things result from shifting the application date earlier in the season. One is because of reduced temperatures, the likelihood of offsite movement from volatility is reduced. The other is the likelihood of sensitive crops being present is reduced. Both should help address offsite movement. However, it could limit the ability of growers to apply dicamba if weeds emerge later in the season. For example, Figure 1 shows the phenology of several crops grown in Illinois (USDA, 2007; 2010) and when applications of dicamba typically occur (Application Window). Soybean are typically planted late April through mid-June in Illinois (USDA, 2010). Therefore, historically, dicamba was only used as a burndown application which occurred in late March through early May, when few specialty crops that are sensitive to dicamba were actively growing or were early in their development and perhaps not as damaged by dicamba. Planting dates for specialty crops and non-DT soybean range from mid-March through May and these crops would be harvested July through October, depending on the crop (USDA, 2007; 2010). Based on the vacated 2018 registrations which had an application cutoff based on the growth stage of the soybean plant (V4 growth stage) and/or days after planting, dicamba could be used

as late as mid-August for late soybean plantings. This created a large window of time that overlapped with sensitive vegetation and when dicamba applications were allowed leading to conditions when incidents could occur. As part of its 2020 decision making process for uses of dicamba on DT cotton and soybean, the Agency considered two application timing restriction proposals, calendar and growth-stage cutoffs, described below, to address when sensitive crops are actively growing and OTT dicamba applications are applied and control offsite movement of dicamba to these crops.

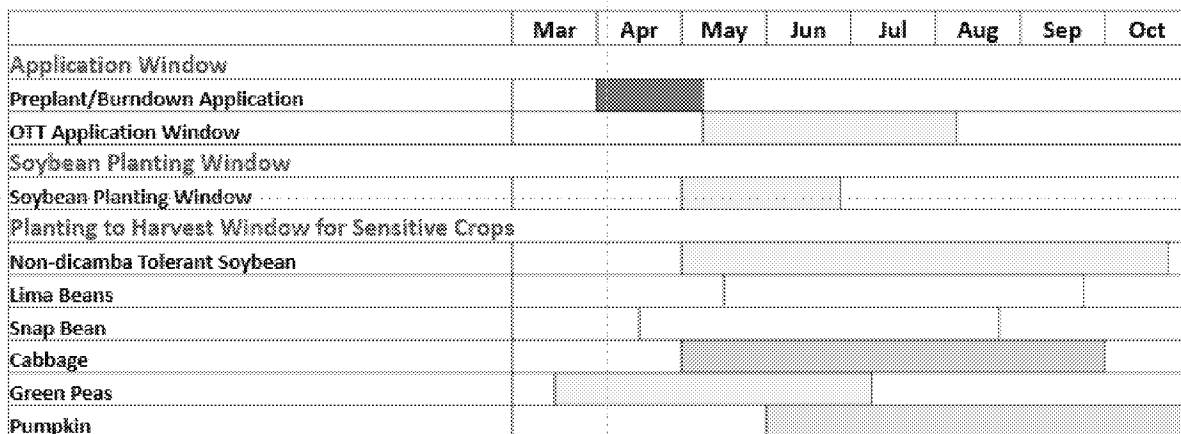


Figure 1. Timing of dicamba application to soybean and phenology of soybean and representative sensitive crops, Illinois. Cotton is not included as cotton is not grown in IL. Sources: USDA, 2010; USDA, 2007.

National calendar cutoff dates - Calendar cutoff dates that have been proposed for OTT dicamba applications are June 30 (roughly equal to June 28, Figure 2) for soybean and July 30 (roughly equal to July 28, Figure 2) for cotton. Figure 2 represents the cumulative number of reported dicamba incidents averaged by week for 2018 and 2019 (Miller, 2020) and the percent of the cotton and soybean crop that could be treated by a given week based on crop progress reports for 2015 – 2019 (USDA-NASS, 2020a; 2020b).

To estimate the percent of soybean likely to receive two OTT dicamba application, BEAD uses USDA Crop Progress Reports for 2015 – 2019 (USDA-NASS, 2020b). BEAD makes a conservative assumption that the OTT dicamba applications would be made 21 days after emergence, when a residual herbicide effectiveness would decline such that weeds would escape and the field would need herbicide applications to control emerged weeds. The second application would be made 21 days after the first application, where we assume a residual herbicide applied with the first application of dicamba would begin to lose effect. BEAD notes, that applications could be made closer together than 21 days, which would result in more acres being treated than are currently estimated. Therefore, BEAD estimates the percent of soybean acreage that would receive one or two applications by taking the midpoint between emergence and emergence plus 21 or 42 days, to allow two flushes of broadleaf weeds to emerge, respectively (USDA-NASS, 2020b) (Figure 2). A June 30 cutoff date for soybean represents a

period where 55% of the incidents could potentially be prevented and 84% of the soybean crop could be treated at least once and nearly 45% could be treated twice with dicamba. This analysis relies on previous incident reports and does not take into account control measures being considered as part of the 2020 decision.

In contrast, a prohibition against applications of dicamba after July 30 for cotton would affect far fewer acres. Over 90% of cotton could be treated at least twice. For cotton, BEAD determined when nationally 80% of cotton is typically planted (USDA-NASS, 2020a). Then 7 days was added to the planting date estimate for emergence, and either 21 or 42 days, to allow one or two flushes of broadleaf weeds to emerge (as describe earlier in soybean), were added to the emergence date to estimate one or two OTT applications, respectively. A July 30 cutoff date for cotton represents a period where more than 90% of the crop could be treated twice but less than 5% of the incidents could potentially be prevented. This analysis relies on previous incident reports and does not take into account control measures being considered as part of the 2020 decision.

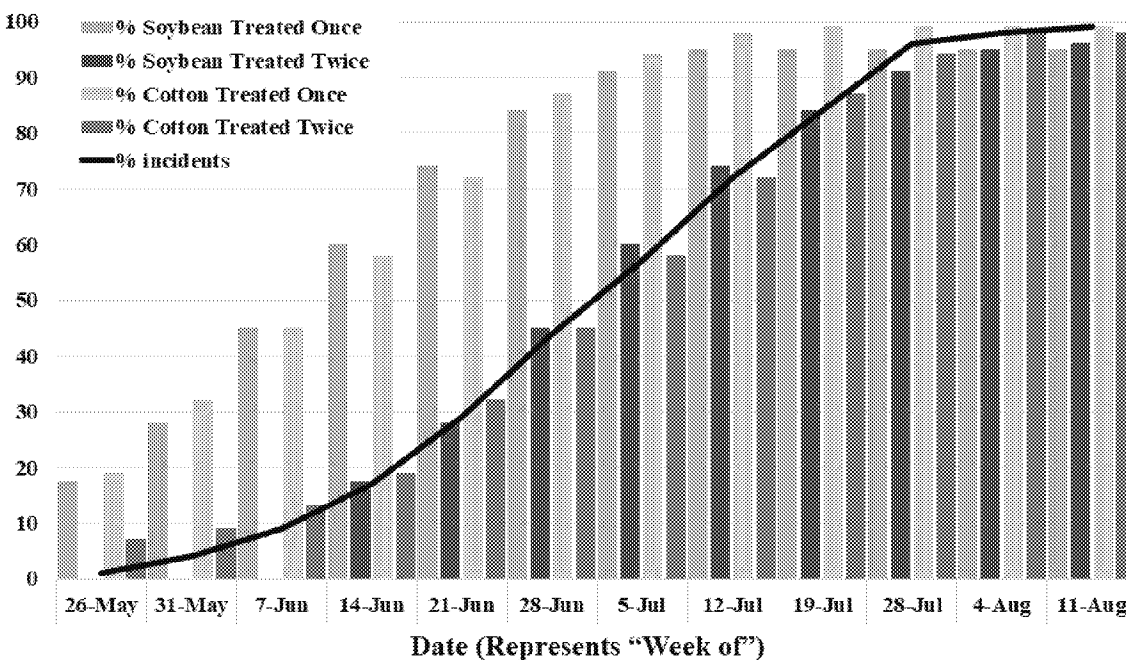


Figure 2. National incidents and cutoff dates for the one and two over-the-top applications of dicamba to cotton and soybean.

Source: Crop Progress Reports for 2015 – 2019 (USDA-NASS, 2020a) and Incident data for 2018 and 2019 (Miller, 2020).

Regional calendar cutoff dates – Because planting dates and crop development varies regionally, BEAD examined possible regionally based calendar cutoff dates. Using the same methodology as with national cutoff dates, BEAD used USDA Crop Progress Reports for 2015 – 2019 (USDA-NASS, 2020b) for Arkansas, Iowa, and North Dakota to represent the Sothern, Central

and Northern soybean production regions, respectively, to estimate the amount of soybean that could be treated once with an OTT application of dicamba. Similarly, BEAD used USDA Crop Progress Reports for 2015 – 2019 (USDA-NASS, 2020a) for Texas, Mississippi, and Georgia to represent the Western, Mid-South and Southeast cotton production regions, respectively, to estimate the amount of cotton or soybean that would be treated within different regions. Incident data were not analyzed regionally because the number of samples by individual states is too small.

Two metrics were considered when analyzing regional cutoff dates for soybean – at least 80% of soybean being able to be treated once and 10% of soybean being treated more than once with OTT applications of dicamba (Orlowski and Kells [2020b] estimated 10% of soybean is treated twice with OTT dicamba). For the Southern Region, June 21 would allow 80% of soybean to be treated once and 50% to be treated twice (Table 3). For the Central Region, June 21 would allow 80% of soybean to be treated once and 33% to be treated twice, and June 28 would allow 84% to be treated once and 37% to be treated twice in the Northern region.

Table 3. Regional Cutoff Dates for Soybean Based on the Estimated Percent of Soybean that Could Be Treated with One or Two Applications (app) 21 or 42 Days after Emergence (DAE) at a Given Date.

Date	Percent Treated at a Given Number of Applications					
	Southern Region (Arkansas)		Central Region (Iowa)		Northern Region (North Dakota)	
	1 app. (21 DAE)	2 app. (42 DAE)	1 app. (21 DAE)	2 app. (42 DAE)	1 app. (21 DAE)	2 app. (42 DAE)
10-May	21	-	-	-	-	-
17-May	31	6	-	-	-	-
24-May	42	12	-	-	-	-
31-May	53	21	33	-	-	-
7-Jun	64	31	48	-	37	-
14-Jun	73	42	64	-	54	-
21-Jun	80	53	80	33	70	-
28-Jun	86	64	91	48	84	37
5-Jul	90	73	96	64	94	54

Source: USDA-NASS, 2020b

Two metrics were considered when selecting regional cutoff dates for cotton – 80% of cotton being able to be treated once and 40% of cotton being treated more than once with OTT applications of dicamba (Orlowski and Kells, 2020a). For the Mid-South Region June 28 would allow more than 80% of cotton to be treated once and nearly 50% to be treated twice (Table 4). For the Southeast Region July 5, would allow 90% of soybean to be treated once and 50% to be treated twice and July 12 would allow 90% to be treated once and over 40% to be treated twice in the Western region.

Table 4. Regional Cutoff Dates for Cotton Based on the Estimated Percent of Cotton that Could Be Treated with One or Two Applications (app) 21 or 42 Days after Emergence (DAE) at a Given Date.

Date	Percent Treated at a Given Number of Applications					
	Mid-South (Mississippi)		Southeast (Georgia)		Western (Texas)	
	1 app. (21 DAE)	2 app. (42 DAE)	1 app. (21 DAE)	2 app. (42 DAE)	1 app. (21 DAE)	2 app. (42 DAE)
28-Jun	89	47	80	32	62	23
5-Jul	95	69	90	51	82	34
12-Jul	98	83	95	68	91	44
19-Jul	99	89	99	80	95	62
26-Jul	100	95	-	90	-	82
2-Aug	-	98	-	95	-	91
9-Aug	-	99	-	99	-	95
16-Aug	-	100	-	-	-	-

Source: USDA-NASS, 2020a

Crop stage cutoff – As part of their 2020 registration applications, registrants initially submitted a request for restricting applications to be made no later than 60 days after planting or mid-bloom for cotton (no change from the vacated registrations). And the registrants proposed to restrict soybean applications to 30 days after planting or V4 (the vegetative stage with four true leaves) (a change from 45 days after planting or V6).

A crop stage cutoff could reduce the window of application; however, it would be at a field level, not a landscape level and, by itself, would not prevent harm to adjacent sensitive crops. This is an important factor because planting dates vary between different fields which means the growth stages and therefore application dates of dicamba will vary between fields (Figure 1). Additionally, growth stage does not consider the neighboring sensitive vegetation (e.g., lima beans, green beans, non-DT soybean, pumpkin, Figure 1) and the concern with offsite movement is the impact to neighboring vegetation, not the DT field where the application is made. The growth stage terms “mid-bloom” (cotton) or V4 (soybean), can be difficult to interpret over an entire field by the grower/applicator, especially given that there is variability within a field.

When considering all the types of possible cutoff dates, there are advantages and disadvantages to each. All cutoffs pose restrictions on when applications can be made and can reduce the application window for growers. Of the cutoffs being considered, a national cutoff offers the greatest label clarity. BEAD acknowledges that some growers may be impacted differently with southern growers having an advantage over northern growers with a national cutoff date. With regional cutoff dates, there is concern that state borders do not coincide with crop production (e.g., cotton is grown only in five counties in the bootheel of Missouri) and could cause some

farmers to be impacted at a different level than others in neighboring states. When considering a calendar date based cutoff or a growth stage cutoff, a calendar date can help address landscape effects because it is a finite date regardless of planting date, whereas a growth stage cutoff allows for applications to occur on a field by field basis over a longer period of time due to the long planting window.

Separate Label for Herbicide-Tolerant Crops

If directions for use of dicamba products on dicamba-tolerant crops were described on a separate product label from all other dicamba registered uses it would be easier for users to follow the directions. From 2016 through 2020 the label had almost 20 different crops listed including dicamba-tolerant and non-tolerant cotton and soybean. A separate label for OTT crops would not have multiple directions for use for cotton and soybean or any other crop, fewer pages and reduce the complexity for the user.

Application Rate Reductions

The 2018 registrations allowed OTT dicamba to be applied preemergence plus postemergence on cotton and soybean at up to 2.0 lbs. a.e. per acre per year maximum label rate. But the average use, preemergence and postemergence to the crop, on cotton was 0.32 lbs. a.e. per acre preemergence and 0.41 lbs. a.e. per acre postemergence and on soybean was 0.35 lbs. a.e. per acre preemergence and 0.48 lbs. a.e. per acre postemergence (Orlowski and Kells, 2020a, b). The preemergence single application rate of 1.0 lbs. a.e. per acre has been reduced to 0.5 lbs a.e. per acre but since the current preemergence use rate is well below this level impacts are not anticipated. A reduced application rate might not be effective on difficult to control weed species or could increase the cost to manage weeds because of a need for additional active ingredients to be applied for optimum weed control.

Number of Applications

OTT dicamba can be applied more than once to a crop to control different weeds that emerge at different times or multiple emergence events of the same weed. In 2019 in the U.S., an average of two applications of OTT dicamba were made to 40% of the cotton acres treated with dicamba and 8% of the soybean acres treated with dicamba (Orlowski and Kells, 2020a & b). The Agency did not assess the impact of reducing the number of applications so the impact on risk has not been estimated (USEPA. 2020c) but limiting the number of applications can be expected to decrease risk, generally. In addition, fewer applications would reduce the selection pressure on dicamba resistant weeds. However, fewer applications might create concerns by the user about season long weed control or the potential need to purchase a different herbicide for season long control. Since the number of applications were not reduced there should be no impacts to users.

Spray Drift

There are a number of factors that can impact spray drift such as droplet size, spray release height, wind speed, temperature inversion, and the interactions of these factors.

Droplet size - The Agency is implementing a control measure for droplet size because coarser droplets (as defined by ASABE S572) have been demonstrated to decrease spray drift and, therefore, address potential risks to non-target species. In general, potential negative impacts to growers from requiring larger droplets could include reductions in efficacy (Butts et. al., 2019) and increased selection pressure for the evolution of resistance due to a decrease in lethal dose delivered to target pests, increased application rates used by growers, increased costs associated with reduced yield, more pesticide applications, the purchase of alternative products, or an inability to use tank mix or premix products. The extremely coarse to ultra-coarse droplet size required for dicamba applications can lead to poor control of another pesticide when co-applications are made with pesticides that require a medium droplet. Since this measure was already in place there should be no impacts to users.

Release Height: The Agency is implementing a control measure for the spray release height above the crop canopy of no more than 24 inches for dicamba. Spray release height is important to minimize overlap of spray from nozzles while maintaining proper coverage. Nozzles placed too low will not provide adequate coverage, they may not overlap spray from the adjacent nozzle properly and could lead to portions of the field not receiving a pesticide application. Untreated areas can harbor weeds and could lead to re-infestation of treated areas and result in increased pesticide use. Nozzles placed too high could lead to increased offsite movement. A grower may have to purchase new nozzles to accommodate a maximum spray height of 24 inches above the canopy (the only allowed height), make adjustments to their boom or apply a different chemical that does not have this release height requirement which could be more expensive and/or less efficacious. At least one of the nozzles recommended for use with dicamba (TT jet induction nozzles) has manufacturer recommendations that indicate the optimal release height is 20 inches but a slightly higher release height would be effective (Teejet, 2020). Therefore, the Agency does not expect impacts from restricting release heights to no more than 24 inches above the crop canopy. Since this measure was already in place there should be no impacts to users.

Wind Speed: Wind conditions vary across the U.S. and wind speed restrictions (that is, prohibitions against application when the wind speed is less than 3 mph or greater than 10 mph) could prevent timely applications of dicamba. There is limited information available on general practices of pesticide applicators; however, Bish and Bradley (2017) conducted a survey of more than 2,000 certified pesticide applicators in Missouri. They found that most applicators are aware of wind speeds when making herbicide applications, most applicators typically apply at wind speeds of 15 mph or lower (more than 65% of Missouri applicators consider it too windy to spray above 10 miles per hour and nearly 25% indicate that greater than 15 miles per hour is too windy). However, there are situations (e.g., when rain and other weather conditions are right for

application, when pest pressure is high, etc.) when some applicators will spray at wind speeds greater than 15 mph (less than 10% of survey respondents).

Mandatory wind speed restrictions complicate pest and crop management by reducing the available time to make applications and make it more likely that a grower may need to alter pest control plans. The Agency will maintain the previous range of wind speeds when applications could occur (3 to 10 mph). Because this was on a previous label, universities have conducted analyses on how these wind speed limitations impact a grower's ability to apply OTT dicamba. For instance, a study from Iowa demonstrated that in July 5 – 18, 2020 there were only 40 suitable hours when the winds were between 3 to 10 mph (Hartzler and Jha, 2020). Similarly, in Minnesota, there was an average of 47 hours between June 1 and June 15, 2020 with a range of 0 to 89 hours and much of Central Minnesota had less than 40 hours of ideal applications conditions, that considered both wind speed, rainfall and inversion restrictions (Goplen and Nicolai, 2020). In addition, reducing the hours per day when the applications can be made may result in additional costs such as additional trips to the field, or the need to abandon a tank load of dicamba that cannot be sprayed. If applications are not made in a timely manner, pest control could decline, potentially leading to additional applications or yield losses, and/or accelerate the development of resistance. Since this measure was already in place on previously approved dicamba OTT products, there should be no additional impacts to users.

Temperature Inversions: The dicamba draft labels will prohibit applying dicamba during inversions. This control measure would require that applications could only be sprayed between one hour after sunrise and two hours before sunset, which could result in delays to intended applications and, more generally, reduce the amount of time users have to apply dicamba. Potentially, growers could spray on a different day or switch to a different product that does not have this restriction, which may be more costly. Since this measure was already in place there should be no impacts to users.

Impacts of multiple spray drift measures could be compounded and further reduce the time in which applicators could apply dicamba. For instance, applicators may deal with wind restrictions by spraying early in the morning/late evenings when winds are calmer; however, temperature inversions are more likely to occur several hours before sunset and can persist until 1-2 hours after sunrise. As the window of application gets smaller, growers may need to switch to products without these restrictions. Therefore, the pest control choice may be based on availability, the opportunity to apply, and not performance, which could be costly and reduce pest control.

Hooded Boom Sprayers

EPA generally supports the development and implementation of drift reduction measures and technology such as hooded sprayers. These measures potentially address offsite movement of the pesticide chemical and benefit growers and others, recognizing that, at the same time, they may increase application time and cost. Hooded boom sprayers, a type of drift reduction tool,

have a cover over the nozzles which is designed to address offsite movement of spray particles. The types of hoods can include broadcast, or over the top of the canopy, and row-middle hoods. Hooded spray booms are designed to address spray drift and will not reduce volatility. Hooded row-middle spray applications of OTT dicamba to DT cotton and DT soybean were allowed in 2020 in Georgia under a FIFRA Section 24(c) Special Local Needs registration (Georgia Department of Agriculture, 2020). These applications were to be made with coarse or larger droplets, under a hood that would remain in contact with the soil, and a ground speed of no more than 6 miles per hour. Broadcast hooded boom sprayers have nozzle tips under the hoods to apply chemicals to the crop, and a rounded hood over the nozzles to reduce droplets from escaping into the atmosphere where they can cause damage to nearby sensitive plants. There is limited field-scale information on drift with broadcast hooded booms when used over the top of a cotton or soybean crop canopy or when the wind is parallel to the crop rows.

Approved hooded broadcast sprayers will be an option for soybean growers to reduce buffers size. If adopted by soybean growers, they may benefit growers by reducing buffer distance; however, there are potential limitations to hooded sprayers. Using hooded sprayers would require an additional cost to purchase the equipment and could reduce productivity because: the hood may not cover the entire boom and the user would need to spray a smaller width; purchasing a hood for a boom will increase the cost to the user; significant time is required to install the hoods on the boom; and the sprayer should be operated at a slower speed (e.g., 6 mph maximum based on manufacturer information) (Redball, 2015). In addition, there can be problems keeping the hoods close to the canopy with irregular or undulating fields, the need for extra cleanup time for the hood, potential crop contamination from the hoods, and poor nozzle visibility in case of mis-operating nozzles. If hooded sprayers are optionally used to reduce buffer distances, growers will be deciding for themselves whether to accept the potential limitations in exchange for the benefit of a reduced buffer. Buffer size reductions are discussed in the ecological risk assessment and final decision documents which can be found in the dicamba docket (USEPA, 2020).

Buffer Impacts

In order to address offsite movement of dicamba on adjacent property, the Agency is requiring a 240-foot downwind for all applications, and 310-foot downwind and 57-foot omni-directional buffers for counties where certain threatened or endangered species are present¹ (USEPA, 2020). The requirement of an in-field buffer on the downwind side of the field may require growers to remove land from production, make an additional trip back to treat the field with dicamba OTT when the winds have shifted, or use an alternative weed control program in the buffer areas after

¹ In combination with the 310-foot in-field wind-directional spray drift buffer, a 57-foot omnidirectional infield buffer is required to protect federally listed threatened and endangered species. Non-sensitive areas, defined below, may be included as part of the buffer. The following areas may be included in the buffer distance calculation when directly adjacent to the treated field edges: Roads, paved or gravel surfaces, mowed and/or managed areas adjacent to field such as rights of way. Planted agricultural fields containing corn, DT cotton, and DT soybeans. Areas covered by the footprint of a building, silo, or other man made structure with walls and or roof.

cleaning out the sprayer. Because omni-directional buffers are smaller they may not impact grower practices as much as the larger downwind buffers.

BEAD estimated the impacts of infield buffers in cotton and soybean over a range of potential buffer sizes, from 110 to 310 feet based on input from EFED (USEPA, 2020). Other parameters in estimating the impacts of a buffer are the type of buffer, field size, and shape of the field. Table 5 shows the percent of a field affected by downwind, in-field buffer. An omnidirectional, in-field buffer would affect almost four times the area, while a buffer that may include area off the field (e.g., a roadway) would affect less area of the field.

The shape of a field may greatly influence the impact that a buffer may have. BEAD estimated the impacts for a rectangular field (i.e., a quadrilateral with a length twice its width), with a buffer along its longer side because it is a more conservative estimate; the affected area would be less for a square field or if the buffer were along the shorter field edge while the area affected could be larger for other shapes. The size, shape, and location of a field and what is on the adjacent land will determine how many sides of a field need to have a buffer. BEAD does not have data on the typical shapes or locations of fields within a given farm.

BEAD does have data on typical national field sizes from the USDA Farm Service Agency (FSA) for five years (USDA FSA, 2010-2014). The FSA defines a field as an area within a farm that is separated by permanent boundaries such as fences, permanent waterways, woodlands, and roads. Using data from USDA FSA, BEAD estimated the impacts to small (10th percentile), median (50th percentile) and large (90th percentile) cotton and soybean fields (Table 5). The impacts presented are the change in acres and percent of field impacted by a given buffer distance. Table 5 provides estimates of the percentage of a treated field impacted by one sided or downwind buffers for three buffer lengths. Table 5 includes the percent of fields impacted by 110-foot buffers that were in place in 2019-2020, the 240-foot buffer that could be used for some fields, and the 310-foot buffer that could be used in counties where endangered species are present. Table 6 provides estimates of impacts of the percentage of a treated field impacted by four sided or omnidirectional buffers to be used if a field is planted in a county where endangered species are present.

Crops could still be grown in the entire field, but herbicide applications would have to be modified in the buffer area. Because of these modifications, these buffers may be difficult for growers to incorporate into their production practices, complicating weed control adjacent to the field borders, as described here (Hartzler, 2018). To control weeds in the buffer areas, users could apply another herbicide program to the field buffers, wait until the wind shifted away from sensitive sites for FIFRA downwind buffers, leave the land fallow or plant a grassed buffer strip. If an alternative weed control program were used the applicator would need to wash all dicamba residues from the tank or have a sprayer dedicated to dicamba applications which would increase fixed costs. A recent publication indicates that the sprayer must be triple rinsed in order to remove sufficient dicamba residues so that other plants are not damaged (Browne et al., 2020). The process of triple rinsing a sprayer is anticipated to take one to four hours before other

herbicides can be applied (Kruger, personal communication 2020). The additional time to clean the sprayer and apply an alternative herbicide would reduce the time available for spraying an herbicide to manage weeds in the field and increase labor costs.

To assess the impact of the downwind buffer, BEAD calculated the amount of a field that would be affected assuming a rectangular field (i.e., a quadrilateral with a length twice its width), with a buffer along its longer side. For the one-sided buffers on cotton (Table 5) the 240-foot buffer would affect (i.e., a user would need to use an alternative weed control program) 39% of a field in the 10th percentile by size, 18% of a 50th percentile field, and 10% of a 90th percentile field. For cotton, a 310-foot buffer would impact 51% of a 10th percentile field, 24% of a 50th percentile field, and 13% of the a 90th percentile field. For soybean, the 240-foot buffer would impact 46% of a 10th percentile field, 22% of a 50th percentile field, and 13% of a 90th percentile field. For soybean the 310-foot buffer would impact 59% of a 10th percentile field, 29% of a 50th percentile field, and 17% of the a 90th percentile field. If a field is near sensitive sites or in counties with Endangered Species, substantial portions of the field may have to be treated differently because of buffers, users could apply two different herbicide programs or growers may forgo using dicamba OTT. If a field does not meet those criteria (near sensitive sites or in counties with endangered species) than it would not be impacted.

Table 5. Distribution of Cotton and Soybean Field Sizes and Impacts from One Sided or Downwind Infield Buffers on Rectangular Shaped Fields Where the Buffer is on the Long Side.

Crop ¹	Buffer	10th Percentile		50th Percentile		90th Percentile	
		Field Size Acres ²	Percent Impacted by Buffer (acres)	Field Size Acres ²	Percent Impacted by Buffer	Field Size Acres ²	Percent Impacted by Buffer
Cotton	110 ft	17	18% (3 A)	78	8% (7 A)	250	5% (12 A)
	240 ft	17	39% (7 A)	78	18% (14 A)	250	10% (26 A)
	310 ft	17	51% (9 A)	78	24% (19 A)	250	13% (33 A)
Soybean	110 ft	12.5	21% (3 A)	54	10% (6 A)	148	6% (9 A)
	240 ft	12.5	46% (6 A)	54	22% (12 A)	148	13% (20 A)
	310 ft	12.5	59% (7 A)	54	29% (15 A)	148	17% (26 A)

Footnotes: ¹ Average (5-yr) annual sample size in cotton was 329,776 fields and in soybean was 2,975,287 fields (USDA FSA, 2010-2014).

² Size of the field at the given percentile (e.g., in cotton the 10th percentile in terms of acreage is comprised of fields 17 acres or smaller). Percentiles are based on acreage. For both cotton and soybean, the 10th percentile in size based on acres includes approximately 50 percent of the fields, the 50th percentile in size includes approximately 85% of the fields, and the 90th percentile in size includes 99% of the fields.

For the four sided or omnidirectional buffer (Table 6) for cotton which was calculated at 57 feet based on input from EFED (USEPA, 2020). A 57-foot buffer could impact (i.e., a user would need to use an alternative weed control program) 25% of the 10th percentile of field size, 12% of a 50th percentile of field size, and 7% of a 90th percentile of field size. For soybean a 57-foot

buffer would impact 29% of the 10th percentile of field size, 14% of a 50th percentile of field size, and 9% of a 90th percentile of field size.

Table 6. Distribution of Cotton and Soybean Field Sizes and Impacts from Four Sided or Omnidirectional Infield Buffers on Rectangular Shaped Fields.

Crop ¹	Buffer	10th Percentile		50th Percentile		90th Percentile	
		Field Size Acres	Percent Impacted by Buffer (acres)	Field Size Acres	Percent Impacted by Buffer	Field Size Acres	Percent Impacted by Buffer
Cotton	57 ft	17	25% (5 A)	78	12% (10 A)	250	7% (18 A)
Soybean	57 ft	12.5	29% (4 A)	54	14% (8 A)	148	9% (14 A)

Footnotes: ¹ Average (5-yr) annual sample size in cotton was 329,776 fields and in soybean was 2,975,287 fields (USDA FSA, 2010-2014).

² Size of the field at the given percentile (e.g., in cotton the 10th percentile in terms of acreage is comprised of fields 17 acres or smaller). Percentiles are based on acreage. For both cotton and soybean, the 10th percentile in size based on acres includes approximately 50% of the fields, the 50th percentile includes approximately 85% of the fields, and the 90th percentile includes 99% of the fields,

pH Buffering Adjuvants and Drift Reducing Adjuvants

Two types of adjuvants are being considered – one is a drift reduction adjuvant and the other is a pH buffering adjuvant. There is evidence to show that as the pH of a solution containing the dicamba salt, in the products for use on DT crops, is lowered, dicamba forms the more volatile dicamba acid. By adding a pH buffering adjuvant, the spray solution can be kept closer to a neutral pH, and therefore the dicamba will remain in a less volatile form. The pH buffering adjuvants reduce volatility but would not reduce offsite particulate drift (spray drift). Drift reduction adjuvants can reduce the number of fine droplets produced by nozzles. These finer droplets are more likely to drift. The purpose of the addition of these types of adjuvants is to reduce spray drift, not volatility.

According to information provided by two registrants, a buffering agent may cost growers \$1 to \$2 per application per acre (BASF, 2020; Bayer, 2020b). A drift reduction agent may cost growers \$1 to \$4 per application acre (BASF, 2020; Bayer, 2020b). Both adjuvants together would cost growers \$2-\$6 per application per acre. Postemergence dicamba costs \$9 per application per acre in cotton (Orlowski and Kells, 2020a) and \$12-\$13 per application per acre in soybean (Orlowski and Kells, 2020b). The requirement of both additives would increase the cost of dicamba to \$11-\$15 per application per acre in cotton, and to \$14-\$19 per application per acre in soybean.

Since many growers make two postemergence applications of dicamba, requiring the addition of a buffering adjuvant or a drift reduction adjuvant would increase the cost of a two-trip postemergence dicamba program by \$2 to \$4 per acre or \$2 to \$8 per acre, respectively. Requiring both adjuvants could increase costs by \$4 to \$12 per acre. The added cost will reduce the benefit of dicamba relative to other control options. A postemergence program with two applications of dicamba was estimated (Orlowski and Kells, 2020a & b) to be up to \$14 per acre cheaper than alternative herbicide programs in soybean and in cotton (increasing grower net operating revenue by up to 10% in cotton and up to 7% in soybean). The additional costs of the additives could largely eliminate these savings, but even with the additional costs, a postemergence dicamba program may still be cheaper than some alternative programs.

An example of the impact of requiring a drift reduction adjuvant and a pH buffering adjuvant, using soybean production in the Corn Belt, is provided in Table 7 below. This table is based on Orlowski and Kells (2020b). Without any adjuvants, the postemergence dicamba program is cheaper than a postemergence 2,4-D program. Using the lower bound estimate of the cost of the two adjuvants, the dicamba tolerant program is still cheaper, on average, than the 2,4-D program. However, using the upper bound estimate of the cost of the two adjuvants, the dicamba tolerant program would be similar in cost to the 2,4-D program. This illustrates that the requirement of the adjuvants may eliminate any cost advantage that postemergence dicamba holds against alternative chemical programs.

Table 7. Comparing Per-Acre Benefits of Postemergence Dicamba Programs on DT Soybeans in the Corn Belt, with required adjuvants

	2,4-D Tolerant Program⁵	Dicamba- Tolerant Program⁶	Dicamba with Adjuvant⁶ (Lower Estimate)	Dicamba with Adjuvant⁶ (Upper Estimate)
Gross Revenue	\$524	\$524	\$524	\$524
Postemergence Herbicide Costs	\$56	\$44	\$44	\$44
Adjuvant (DRA and VRA) Cost ¹	-	-	\$4	\$12
Other Operating Costs ^{2,3}	\$89	\$89	\$89	\$89
Seed Cost ⁴	\$57	\$57	\$57	\$57
Net Operating Revenue	\$322	\$334	\$330	\$322
Change in Net Operating Revenue Switching to Postemergence Dicamba		\$12	\$8	\$0
Percent Increase in Net Operating Revenue Switching to Postemergence Dicamba		3.7%	2.5%	0.0%

Source: Budgets from USDA ERS (2020c).

1 This cost is for two applications of a drift reduction agent (DRA) and a pH buffering agent (VRA).

2 Other operating costs include preemergence herbicides, fertilizer, custom services, fuel, lube, electricity, repairs, hired labor, and interest on operating capital. BEAD includes labor in operating costs even though ERS includes labor in overhead. BEAD excludes family labor.

3 Preemergence herbicides are assumed to be one trip with paraquat and one trip with s-metolachlor and metribuzin. The cost of this preemergence program is calculated to be \$20 per acre in the Corn Belt (Kynetec, 2019).

4 Seed costs are regional average over conventional and GM seeds – budgets do not account for variation in seed costs between herbicide-tolerance traits, or variation in seed costs within herbicide-tolerance traits.

5 Postemergence herbicides include a first pass with glufosinate and 2,4-D, and a second pass with glyphosate, 2,4-D, fomesafen, and s-metolachlor. Herbicide programs described in Table 5 including Pass 1 and Pass 2. Herbicide costs in Table 8 (Orlowski and Kells, 2020b).

6 Postemergence herbicides include a first pass with glyphosate, dicamba, and s-metolachlor, and a second pass with glyphosate, dicamba, and fomesafen. Herbicide programs described in Table 5 including Pass 1 and Pass 2. Herbicide costs in Table 8.

In addition to monetary costs, requiring growers to utilize a drift reduction adjuvant and or a pH buffering adjuvant will also impose non-monetary costs on growers. The non-monetary costs could include increased managerial effort and training for applicators on the proper procedures for incorporating these additives into the spray mixture as well as increased time to mix and load an appropriate dicamba spray mixture (including both adjuvants) into a sprayer. These non-monetary costs may be enough to impact grower adoption of these dicamba OTT products.

Sprayer Cleaning

Dicamba can cause injury in sensitive crops at very low rates which can occur if the sprayer (spray tank, associated plumbing, and mixing/loading equipment) is not properly cleaned of all dicamba residue. For example, small amounts of dicamba left in a sprayer can cause symptoms such as cupped leaves and stunted growth which look similar at rates between 1/1,000th down to 1/10,000th of the label rate (Riechenberger, 2020). On dry edible beans a tank contamination study demonstrated that dicamba can cause ten times more dry weight damage than 2,4-D (Bales and Sprague, 2020). To properly clean out a sprayer and all of the contaminated surfaces can require triple rinsing (Browne et. al., 2020) and may take from one to four hours (Kruger, personal communication 2020). Additional time to clean a sprayer or mixing equipment can impact a user if they are switching to another herbicide to treat another non-DT crop or if they need to change to a non-dicamba program to treat in-field buffers. Since this measure was already in place there should be no impacts to users.

V. ADVERSE EFFECT INCIDENTS

This section describes the adverse effect incidents reported to the Agency by the registrants of dicamba and others and compares these reported incidents to those found by a high-quality independent survey. The magnitude of underreporting of incidents is estimated and potential causes for the underreporting are discussed. As used here, underreporting refers to the difference between the actual number of adverse effects incidents and the number (and to some extent, the detail) reported to the Agency; it does not necessarily signify any violation of a reporting

requirement. This section also discusses adverse effects incidents reported to Agency and cataloged in the Agency’s Incident Data System (IDS) (Miller, 2020). Misuse and noncompliance are also discussed.

Dicamba Related Incidents Reported to the Agency

Incidents showing lack of product performance – Figure 3 shows the number of reports nationally when OTT dicamba was not efficacious or did not perform as expected. These are reports to the Agency of lack of efficacy that are tabulated in the IDS (Miller, 2020). Dicamba was first registered for OTT use in 2016, and first used in 2017, so that was the year the first incidents were reported. Between 2017 and 2019, the number of lack of performance reports increased by 60% annually, to almost 1,300 in 2019 (Figure 3). This lack of efficacy could be due to improper application of the herbicide, the weeds not being at the correct growth stage at the time of application, negative interaction of tank mix partner (i.e., antagonism), the presence of dicamba resistant weeds, or reduced sensitivity in the weeds (an early sign that dicamba-resistant weeds may be present). The Agency has information about multiple cases of suspected dicamba-resistant Palmer amaranth and waterhemp populations, but widespread dicamba-resistant Palmer amaranth and waterhemp has not been confirmed.

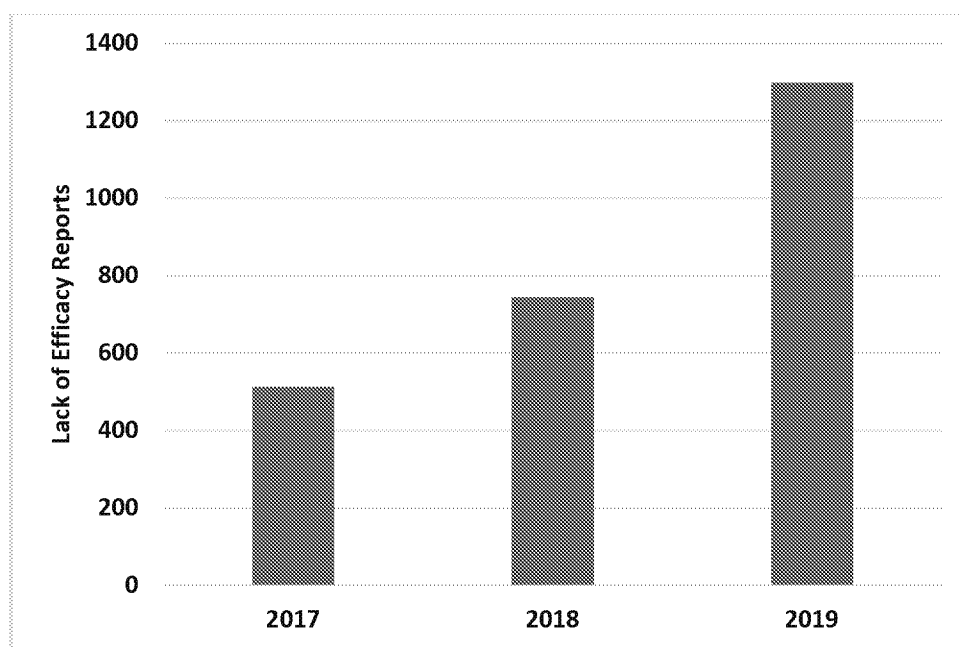


Figure 3. Number of dicamba over-the-top lack of efficacy reports from 2017 to 2019.

Source: Miller, 2020.

Incidents related to offsite movement of dicamba - Several thousand incidents, over three years, have been reported to the Agency alleging offsite movement of dicamba. The offsite movement may be due to misuse of the OTT products previously registered (e.g., not following the label) or

misuse of other types of dicamba products (use of an older, more volatile formulation not approved for application on non-DT crops), drift to adjacent crops or sites, tank contamination (e.g., dicamba was not completely removed from the spray equipment and is sprayed on the next field at a lower concentration), or volatility (the dicamba was applied and then moved off the treated area after the application process was completed). Dicamba has a history of volatility, research on early formulations has demonstrated that nearly half of the applied material was lost due to volatility (Burnside and Lavy, 1966). The Agency has primarily received incident data related to dicamba from AAPCO (AAPCO, 2020b; 2020c; 2020d; 2018) and registrants.

During the 2017 use season, approximately 2,700 dicamba incidents, affecting about 3.6 million acres, were reported to university extension personnel and state lead agencies related to offsite movement of dicamba (Bradley 2017). This is similar to the number of incidents reported to the EPA by the OTT dicamba registrants under FIFRA 6(a)(2) and 40 CFR 159.152. In 2018, data from Bradley were not available, but AAPCO (2020b) indicated there were 1,218 incidents. Because of the differences in the methods of gathering data between the two sources is inconsistent across states (see Underreporting of Incidents to the Agency section, below), a conclusion that the total number of incidents declined between 2017 and 2018 cannot be made. Dicamba OTT registrants, extension agents, academic researchers, and state investigators identified several potential causes for these incidents including physical drift, volatility, tank carry-over or contamination, inconsistent label instruction between products, illegal use of dicamba products not registered for OTT use, and application outside of the permitted environmental conditions.

Through the 2018 approved labeling, registrants made changes to the labels that were in effect for the 2019 use season in response to these incidents. During the 2019 use season, based on reporting to AAPCO, there was an approximate 10% increase in number of incidents from 2018 with 1,218 reported in 2018 compared to 1,345 incidents reported to the states in 2019 (AAPCO, 2020b). Although, reports have continued to increase nationally, there is variability in numbers of reports from individual states; some states (e.g., Kentucky, Missouri, Minnesota, Ohio) have seen a decrease in incidents AAPCO, 2020b.

Dicamba total incidents reported to EPA and recorded in IDS went up from zero reported in 2014 through 2016 to a total of approximately 1,400 in 2017, 3,000 in 2018, and 3,300 in 2019 (Figure 4). In IDS, major plant damage incidents with Exposure Severity Code (more than 45% of crop adversely affected) are required to be submitted to the agency on a monthly basis under FIFRA. Plant incidents are reported as more than 45% of a crop exposed to be adversely affected, less than 45% of a crop exposed, or incident reported but no percent of crop damage provided.

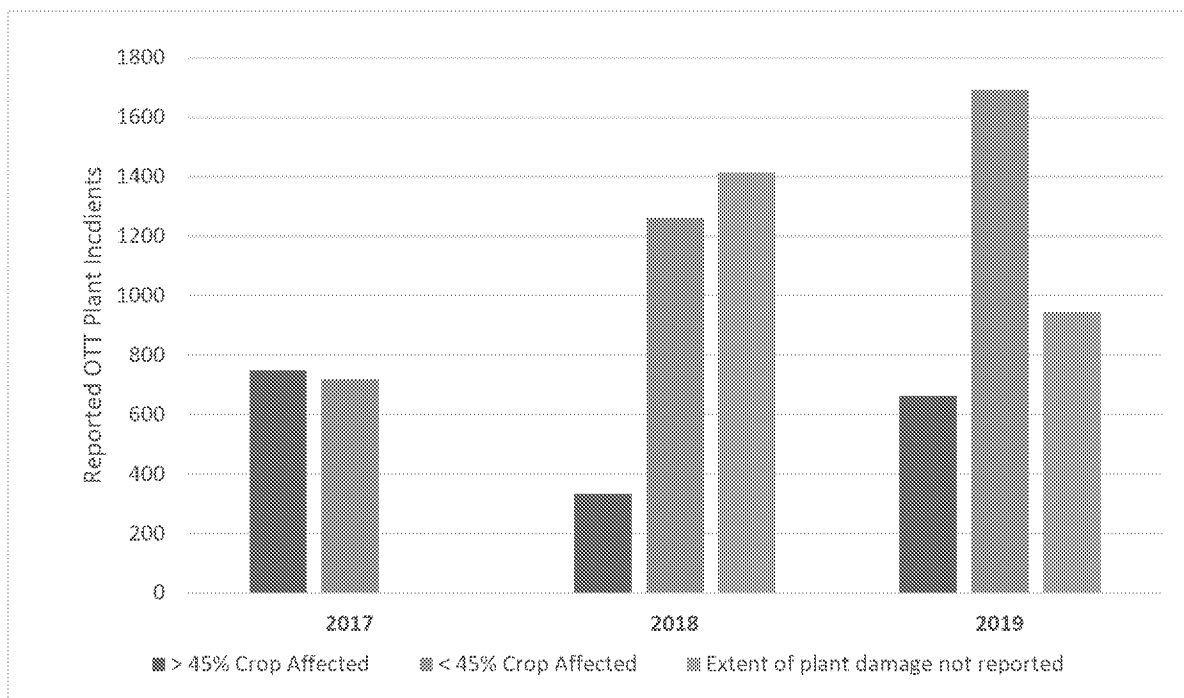


Figure 4. Number of dicamba incidents reported to the Agency's Incident Database System (IDS) from 2017 to 2019.

Source: Miller, 2020

Independent Survey of Dicamba Related Incidents

The Agricultural Resource Management Survey (ARMS) is sponsored jointly by USDA's Economic Research Service (ERS) and National Agricultural Statistics Service (NASS). ARMS is USDA's primary source of information on the production practices, resource use, and economic well-being of America's farms and ranches. The ARMS samples about 30,000 farm and ranch operations and is conducted in three phases. In Phase II, farm operators are interviewed regarding their production practices and chemical use. The collected data are specific to an individual field (USDA, 2020b).

The ARMS samples farms based on strata that group farms based on regions, farm size, and commodity specialization. Farms in different strata are sampled with a different probability of selection so that each stratum has a representative number of surveyed farms. Within a stratum, the weight (expansion factor) is based on the probability of each sampled unit's selection. The ARMS sample is not a simple random sample. Each observation has a different weight, or expansion factor, to reflect its probability of selection and, therefore, what part of the sampled universe it represents. Full survey documentation is available on the ERS website (USDA 2020b).

Soybean growers were surveyed in 2018 (USDA, 2020a), including questions about the occurrence of visual signs of injury (VSI) related to dicamba. Dicamba produces characteristic VSI that are unlikely to be mistaken for other plant effects (Unglesbee, 2018). Wechsler et al. (2019) reported the results of the survey. At the request of BEAD, ERS conducted a special tabulation of the data from the 2018 Soybean and 2019 Cotton ARMS (fulfilled on 8/28/2020, Appendix 1). These reports (USDA, 2020a), while checked for logical errors, did not go through the normal rigorous ERS peer review process. BEAD compared the tabulations to the data in the published report (Wechsler et al., 2019) and did not identify any discrepancies between the two sets of data.

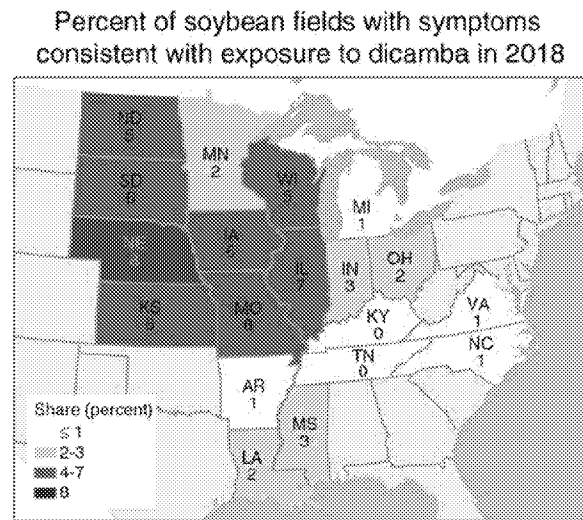


Table 8. Soybean Growers Observations and Awareness of Dicamba Damage, 2018.

Survey Question	'Yes' Response (Weighted Frequency)	Percent	Weighted Sum of Planted Acres	Confidence Interval for Weighted Sum of Planted Acres	
				Lower 95 th Percentile	Upper 95 th Percentile
<i>"Did you observe "cupping" or other symptoms associated with dicamba drift/volatility on the selected field in 2018? "</i>	64,497	3.88	4,191,569	2,835,757	5,547,382
<i>"As far as you are aware, did farmers in neighboring fields observe "cupping" or other symptoms associated with dicamba drift/volatility in 2018?"</i>	166,174	10.05	11,297,970	9,457,060	13,138,879
<i>"As far as you are aware, did farmers in your county observe "cupping" or other symptoms associated with dicamba drift/volatility in 2018?"</i>	255,818	15.43	15,661,221	13,217,464	18,104,978

Source: USDA 2020a; see Appendix I.

These three questions probe the grower's knowledge of dicamba damage (i.e., VSI) on their soybean field being surveyed, their neighbor's fields, and at the county level. Nearly four percent of all soybean growers have seen VSI on their fields consistent with dicamba exposure (Table 8). This represents nearly 65,000 soybean fields totaling 4.1 million acres. About 10% of the total soybean growers in the survey were aware of dicamba VSI on their neighbor's soybean fields. This represents about 166,000 fields representing 11.3 million acres. More broadly, about 15% of the growers in the survey were aware of dicamba VSI on soybean in their county. This represent about 256,000 growers producing soybean on about 15.6 million acres.

There has been significant outreach to dicamba applicators and soybean growers on how to identify dicamba damage and how to distinguish it from other types of herbicide injury (Gunsolus, 2018; Werle, et al., 2018.; Andersen and Hartzler, 2020; Specht, et al., 2018; Hartzler and Anderson, 2018; Unglesbee, 2018; Loehr, 2017). The Agency posits that most soybean growers, including those that participated in the ARMS, have a basic understanding of how to recognize dicamba damage. Because of this level of understanding by handlers and growers, misidentification of the herbicide causing the damage is likely to be 10% or less; less trained individuals could have a much higher rate (Hartzler, 2020b).

Comparing the dicamba soybean incidents reported to the Agency (about 2,600 in 2018) with those from the ARMS (about 65,000 in 2018, reflecting only those growers reporting VSI on their own fields) show that the magnitude of underreporting is significant. The ARMS study estimates that adverse effect incidents to soybean growers alone is approximately 25 times the

number of dicamba incidents reported to EPA for all crops. Because the ARMS only included soybean growers, these results cannot be extrapolated to growers of other crops.

Underreporting of Incidents to the Agency

FIFRA section 6(a)(2) requires that registrants who have additional factual information regarding unreasonable adverse effects on the environment associated with their pesticides must submit such information to the Agency. It does not require registrants to actively seek out or investigate such information, so their reporting obligation is limited to the adverse effect information that comes to their attention. States, pesticide users, and other persons are not required to report adverse effects information, but some do so voluntarily.

Adverse effect incidents are typically underreported to regulatory authorities. This has been well documented for adverse effects of pharmaceuticals (Alatawi and Hansen 2017), workplace injury (Azaroff, et al. 2002), and occupational illness caused by pesticides (Mehler et al. 2006, Prado, et al. 2017). Even when the incidents involve human health events that are evaluated and reported by trained professionals, less than one percent may be reported in some circumstances (Alatawi and Hansen 2017).

Several studies have investigated underlying reasons for incidents being underreported. Azaroff, et al. (2002) using a ‘filter’ framework to examine the loss of cases through successive steps of documentation, found that workers faced adverse consequences of reporting and used weak reporting systems. Van Der Schaaf and Kanse (2004) identified four groups of factors influenced incident reporting:

- Fear of repercussions – disciplinary actions or of other people’s reactions
- Uselessness – nothing will be done about the problem
- Acceptance of risk – incidents are part of the job and cannot be prevented
- Practical reasons – too time consuming or difficult to submit a report

Ricchio (2018) investigated pesticide drift incidents in the Midwest and identified similar causes (fear of negative repercussions and issues with the reporting process), as well as finding that there is an underappreciation of the benefits of reporting. Ricchio (2018) also conducted a convenience sample survey of individuals in farm related organizations (e.g., Iowa Farmer’s Union). She found that 74% of the respondents reported pesticide drift into their property or work area, but only 30% reported the drift incident to appropriate authorities. The majority of respondents had no idea how to report the drift incident in their state. The Land Connection (2020) and Prairie Rivers Network (2020) offer similar reasons for not reporting. Baldwin (2020) suggests that even if an individual knows how to report a claim, a state may have requirements to file a complaint that is nearly impossible (e.g., must identify the responsible party by name, in writing).

It is likely that the causes for the significant underreporting of dicamba injury and poor product performance differ for each party, as discussed below.

Growers of DT Crops – Several factors likely drive underreporting of dicamba incidents by growers. It is likely that most dicamba VSI would not be reported if the damage was on the grower's property, as the damage is somewhat self-inflicted and may be accepted as the price of raising DT crops. In other cases, where dicamba VSI occurred on a neighbor's field, the two parties may resolve the incident between themselves and not report the incident (McCune, 2017). Some growers have been targets of vandalism and intimidation (e.g., burning hay bales and destroying tractor engines) (Charles, 2020), so the fear of retaliation may prevent reporting. The lack of knowledge of how to report incidents (Ricchio, 2018) would lead to further underreporting. Reports of product failures are to be investigated by the registrants and reported to the Agency under the terms and conditions of the registration. Underreporting by the registrants is discussed more fully below.

Growers of non-DT crops – Underreporting of dicamba incidents may occur due to three reasons. First, dicamba VSI may be accepted as the price of living in an agricultural community and nothing would be done if reported. In other cases, the dicamba incident may be resolved by the two parties and the incident not reported. (McCune, 2017). Because some growers have been targets of vandalism and intimidation (e.g., burning hay bales and destroying tractor engines) (Charles, 2020), growers may not report incidents because of fear of retaliation. The lack of knowledge of how to report incidents (Ricchio, 2018) would lead to further underreporting.

Registrants – Product owners may have concerns over regulatory action, damage claims, and litigation from the reports of adverse effect incidents. Large numbers of offsite movement incidents related to dicamba have resulted in litigations and damage claims against registrants (Bayer, 2020a).

As stated on the product labels, reports of product failures are to be reported to the registrant by the user. These are to be investigated by the registrants and reported to the Agency under the terms and conditions of the registration. Registrants may be reluctant to report product failures or reports of resistance developing as growers may select other, more effective herbicide programs.

Evidence for this has been documented in court filings recently publicly released which indicate that dicamba registrants were aware that illegal applications occurred in 2015 (Carey, 2016) on DT cotton when DT seed was available but no dicamba product was registered for at plant/OTT application on cotton; however, these incidents were not reported to the Agency. Additionally, this source indicates that agents for some registrants were instructed to selectively investigate and report incidents (Monsanto, 2017). Based on this instruction, field representatives for the OTT dicamba registrants likely only investigate incidents reported to them by their customers. This criterion is applied to both the applicator (source of drift) and to any other entities that experienced damage (Monsanto, 2017). For example, if the OTT dicamba product user reported

offsite movement of dicamba, this incident would be investigated, while a grape grower that observes the characteristic dicamba injury symptoms (and is not an OTT dicamba user) would not be investigated. Rather, they would be told to contact the local extension or crop insurance for advice, or they could file a report with the state Department of Agriculture. Given that most of the general public involved with agriculture do not know how to report an incident (Ricchio, 2018), this approach has the effect of strongly biasing the number of incidents reported to and by registrants downward.

State Lead Agencies – The Agency routinely meets with AAPCO and the State FIFRA Issues Research and Evaluation Group (SFIREG). These organizations are a network of officials of states and territories interested in federal/state "co-regulation" of pesticides (USEPA 2020). AAPCO, at numerous points, has provided information of number of dicamba incidents at the state level (AAPCO, 2018; 2020b; 2020c); however, not all states that produce soybean are represented, which could be an additional source of underreporting. For instance, the state of Arkansas does not provide estimates of incidents associated with dicamba (AAPCO, 2020b; 2020d); however, Bunge (2020) indicates that Arkansas had the greatest number of complaints from the top 20 soybean producing states. Some members of AAPCO report zero investigations or did not provide any reports. Some states that reported zero incidents also indicated that they became aware of possible incidents too late in the season to investigate (AAPCO, 2020b). All of the above factors would bias the reported number of incidents downward (AAPCO 2020b).

General Public Involved with Agriculture – Underreporting of dicamba incidents in this group is likely due to a lack of knowledge in several areas. First, the general public may not know how to recognize symptoms of dicamba injury. While symptoms of dicamba injury to plants is very distinctive and relatively easy to identify by most agricultural specialists, it does take some explanation and practice for the untrained public to recognize it. Further, identification of the source may be problematic, especially if the damage is due to volatility and the general public may think (erroneously) that the source must be identified before a report can be made. Even if the source is identified, it may be resolved between the parties rather than reported to state authorities. Next, the incident may be accepted as a "routine" occurrence that "just happens" in agricultural communities. Finally, relatively few members of the general public know how to report an incident to the proper authorities (Ricchio, 2018). These factors, taken together, strongly bias incident reporting downward. Underreporting of adverse effects incidents to the Agency is significant and occurs with all parties.

Misuse

Misuse, or illegal use, can occur by using a dicamba product that is not registered for use on DT cotton or soybean. Historically, only four products [(Engenia™, Fexapan™, Tavium™, and Xtendimax™ (M1768)] were registered for a postemergence (OTT) application timing or application time at or near planting. Misuse can also occur when OTT dicamba is used in a manner inconsistent with its label, for example, by failing to comply with buffer requirements,

wind speed restrictions, exceeding label application rate or frequency, etc. Misuse may be a contributing factor resulting in offsite movement of dicamba.

There have been many anecdotal reports of the use of non-OTT products being used on DT cotton and soybean (Hartzler, 2020a). Most reports lack sufficient detail to determine the prevalence of misuse, or the magnitude of the practice. Further, beginning in 2018, Kynetec USA, Inc., a private marketing research firm and the source of annual pesticide usage information on which registrants and EPA rely, began to flag all survey responses reporting the use of non-OTT dicamba products applied at or after planting to DT soybean and cotton as data errors and these data were amended or excluded from their most recent data product AgroTrak (Malcolm, 2020). In 2016 and 2017 (prior to being flagged as data errors), non-OTT products are listed in the data as being applied at- or after-planting to DT crops (Kynetec, 2019). This is consistent with the findings based on the 2018 soybean ARMS (USDA, 2020a).

However, application timing was not used as exclusion criteria in the 2018 soybean or 2019 cotton ARMS. These surveys collected information about the specific products used and the time at which they were applied to the crop (USDA, 2020a; see Appendix I). Table 9 summarizes the data. The data presented are likely to be underestimates, as data censored by ERS to protect respondent confidentiality was not available for analysis. Note that shaded areas are likely to represent illegal use, as non-OTT dicamba products cannot be used later than 14 to 18 days prior to planting, depending on the application rate.

Table 9. Dicamba Products Applied to Dicamba-tolerant Soybean (2018) and Cotton (2019) and Time of Application based on USDA ARMS.

Measure	Soybean		Cotton	
	OTT Dicamba Products ¹	Non-OTT Products ²	OTT Dicamba Products ³	Non-OTT Products ⁴
Weighted Sum of Treated Acres⁵	21,225,384	6,328,578	3,718,919	5,979,318
Applied Before Planting	3,663,781	985,634	277,035	2,425,074
Percent Applied Before Planting	17%	47%	7%	41%
Applied At- or After Planting	17,561,603	3,342,944	3,441,884	3,554,244
Percent Applied At- or After Planting	83%	53%	93%	59%

Source: USDA, 2020a; see Appendix I

¹ OTT dicamba products used on soybean include Engenia (EPA Reg. No. 7969-345), Xtendimax (M1768; 524-617), Fexapan (352-913).

² Non-OTT dicamba products used on soybean include Dicamba DMA 4# AG (EPA Reg. No. 66330-276), Dicamba DGA 4SC (42750-209), Dicamba DMA 2# AG (66330-277), Banvel + 2,4-D (66330-287), Sterling Blue (1381-248), and Clarity (7969-137). Other products were reported as being used but values were censored for respondent confidentiality.

³ OTT dicamba products used on cotton include Engenia (EPA Reg. No. 7969-345) and Xtendimax (M1768; 524-617).

⁴ Non-OTT dicamba products used on cotton include Clarity (EPA Reg. No. 7969-137), Rifle (34704-861), Dicamba DMA 4# AG (EPA Reg. No. 66330-276), Dicamba DGA 4SC (42750-209), and Dicamba DMA 2# AG (66330-277). Other products were reported as being used but values were censored for respondent confidentiality.

⁵ Treated Acres are defined as the acres that receive pesticide multiplied by the number of times the field received a pesticide application. If a farmer treats 70 acres twice with the same herbicide, the treated acres are calculated at 140 acres.

Shaded Areas Represent is likely to represent illegal use. Non-OTT dicamba products cannot be used later than 14 to 28 days prior to planting (depending on application rate).

Table 9 shows that, in regard to application timing relative to planting, the OTT dicamba products are being used appropriately. Approximately 80 to 90% of the acre treatments are applied after planting. About 10 to 20% of the acres are treated before or at plant. The preemergence treatments are reasonable given that the OTT products do not have a waiting interval before cotton or soybean can be planted. Non-OTT dicamba products (e.g., Clarity, EPA Reg. No. 7969-137), require a minimum accumulation of 1 inch of rainfall or overhead irrigation, and a waiting interval prior to planting (cotton, 21 days; soybean, 14 to 28 days).

Table 9 also shows that, in regard to application timing relative to planting, a significant portion of DT cotton and soybean acres are being treated at- or after- planting with non-OTT dicamba products (i.e., unregistered products). In 2018, about 53% of the after-plant acre treatments (3.4

million) were made with non-OTT products on DT soybean and in 2019, about 59% of the after-plant acre treatments (3.6 million) in DT cotton were made using non-OTT dicamba products.

The other general type of misuse is using a product registered for the use site but failing to follow all label requirements and restrictions. These types of misuse can occur for many reasons:

- Misinterpretation or Incomplete Understanding – Users may misunderstand label statements. Some label restrictions are described in multiple places on the label and depending on the knowledge and experience of the applicator, these statements may be confusing. This problem is exacerbated when labels are complex and lengthy. For example, wind speed requirements can be somewhat ambiguous as the label does not specify if wind speed is to be based on sustained wind speed or wind speed based on wind gusts. Another example would be one label for both conventional and DT crops with different directions for each.
- “Situational” misuse – Applicators may routinely use a registered product correctly, but in some situations may not fully comply with specific restrictions. For example, application of OTT dicamba must be made when wind speeds are between 3 and 10 miles per hour. During the spring/early summer, wind speeds may be variable with speeds falling outside the permitted range during the application. If the wind speed falls within the permitted range at the start of the application, the applicator may complete the application, even if the wind speed exceeds 10 mph for short periods.
- Deliberate misuse – The Agency is aware that some label requirements may be deliberately ignored by some users. State Lead Agencies have primary responsibility for investigation of reported pesticide incidents and any enforcement action.

Compliance / Non-compliance

Generally, the likelihood of non-compliance with label restrictions varies based on the implementation cost and how easily the restriction fits with the current crop production practices. The likelihood of investigation and the penalty for noncompliance are also factors. In some instances, fines for using non-registered dicamba products have been so small that they are seen as insignificant when compared to cost of more expensive OTT products (McCune, 2017).

A restriction that has minimal costs to the user, is easy to implement within the current crop production system and does not result in changes to crop yield or quality would likely have a low non-compliance rate. An example would be a reduction in the maximum label application rate to the maximum rate currently being used. Since the label change would not affect cost or how the pesticide is currently being used, this change would be easily adopted. Conversely, restrictions

that are costly to implement, require changes to current crop production practices, and negatively affect crop yield and quality would likely have a lower rate of compliance.

While the Agency makes the presumption that all label directions will be followed, the practicality of, and compliance with, individual control measures is also a consideration during decision making, as discussed below:

Cutoff date for OTT applications (soybean – June 30; cotton July 30) – Ease of compliance with cutoff dates is likely to differ between cotton and soybean. As soybean develops, the plants will form a complete canopy over the row middles. Once this occurs, weed control becomes less of a concern and entering the field with mechanical equipment is limited (e.g., late season fungicide applications) until harvest because of the resulting plant damage. Depending on the environmental conditions, canopy closure in cotton may not occur, necessitating later applications of herbicides.

In general, this requirement is more easily accommodated by growers in the southern States because of the longer growing season and planting at earlier calendar dates. BEAD notes that there have been reports in which cutoff dates were not followed (Baldwin, 2020a; Steed, 2020b). In some situations, ease of compliance could be influenced by crop progress, weed pressure, and weather. Compliance with the cutoff dates is likely improved by the enhanced recordkeeping requirements by the applicator as part of the RUP classification.

Mandatory use of buffering/drift reduction agents – Ease of compliance with the mandatory use of a buffering and/or drift control agents depends heavily on the availability of product, the cost to the grower, and how difficult the product is to use. These adjuvants will have to be purchased separately by the applicator and added to the tank. There are several hundred herbicide adjuvants on the market (Young et al. 2016). Retailers and distributors may stock only a small number based on their clients' needs. The Agency has no information about the current availability of the required buffering agent and cannot estimate compliance with this measure.

Downwind and omnidirectional buffers – Buffer requirements are explicitly stated on the product labels and include directions for treatment zone awareness (sensitive crops and areas) as well as directions for buffers when winds are shifting. The applicator's integrity, skill, and situational awareness will determine the likelihood of compliance with the buffer requirements. The annual training and the enhanced recordkeeping requirements are important measures to improve understanding of the requirements and, potentially, the likelihood of compliance. The Agency received a letter from a crop consultant looking at soybeans in South Dakota that suggests some growers are not adhering to buffer requirements (Baldwin, 2020a). The complexity of the buffers (varying distances dependent on location (county), wind direction, adjacent sensitive crops or other plants) suggest noncompliance may occur.

Temperature inversions – Two restrictions are on the label to address offsite movement resulting from applications made during temperature inversions. First, application is only permitted

beginning one hour after sunrise, and ending two hours before sunset. Usually inversions start to develop about two to three hours before sunset and may persist until one to two hours after sunrise (Thostenson et al. 2019). Thostenson et al. (2019) also reports that inversions may start to form earlier and persist later in fields with a closed canopy and in areas protected by shelterbelts.

While the label describes indications of the presence of an inversion, no information is provided on how to measure temperatures to determine if one is present. Inversions vary based on microclimates (Thostenson et al. 2019) and may be localized on only part of the field. Required recordkeeping of the start and finish times of the application may improve compliance with application cutoff times, but there is no requirement to report the occurrence of temperature inversions.

Wind speed – Applications may only be made when the wind speed is between 3 and 10 MPH. Compliance with these application parameters may be situational based on varying wind speeds during application. Decisions may also be made based on the need of a timely application and weather forecasts. For instance, if winds increase to 12 MPH during application and the weather forecast predicts rain for the next four days, a grower would have to choose between making applications in a timely fashion (albeit in violation of the label) or following the label and not finishing the application. While noncompliance with this measure is possible, the lack of information about applicator behavior prevents estimating the likelihood of actual occurrence.

Optional use of hooded sprayers to relax buffer distances – Allowing for the optional use of hooded sprayers can increase label complexity as there would be different buffer distance requirements listed in Bulletins Live Two depending on the type of application equipment chosen by the applicator. Hooded sprayers, if they are chosen, are available, and are adopted, may benefit growers by reducing the buffer distances but may also increase the time needed to make the application because tractor speed must be reduced. In this case, growers are deciding for themselves whether to increase the complexity of the application in exchange for the benefit of a reduced buffer.

It is important to note that the number of growers likely to adopt hooded sprayers in the near term is very small because 1) these sprayers are not currently used in cotton and soybean production, 2) manufacturers currently produce only 2,000 units per year, and 3) self-constructed hooded sprayers are not permitted unless the sprayer is tested by a registrant or third-party and found to meet the performance standard.

Lastly, if this option was allowed as a possible relief to buffer distances, BEAD is concerned that buffers are poorly understood and making distinctions between FIFRA and ESA buffers based on application equipment could add an additional layer of complexity and unintentionally result in misuse.

VI. IMPACTS TO NON-USERS

This section describes historical impacts to non-users from the use of dicamba and examines the potential impacts to non-users from the registrations of the OTT dicamba products. If all mandatory control measures on the product labels are implemented there is a high degree of certainty that these will address offsite movement.

State Agency Impacts

State agencies have seen different levels of impact in response to investigating incidents. Investigative costs (e.g., salaries, equipment, travel) ranged from no cost to \$800,000 in 2019 according to a survey conducted by AAPCO (2020b). When looking at costs that states have absorbed, some states have decreased spending. For instance, Indiana spent \$1.2 million in 2017 investigating dicamba incidents, \$2.2 million in 2018 and \$800,000 in 2019. The reason for the increase in 2018 was to build infrastructure to handle incident investigations, which also partially explains the decline in costs in 2019. The decline is also attributed to the way Indiana now handles complaints – an individual has the option to file a complaint for investigation purposes or for documentation purposes only. Illinois has continued to see increased costs between 2017 and 2019 for investigations because incidents have continued to rise in Illinois; whereas other states have indicated they have not experienced increased costs.

In addition to monetary costs, states have had difficulty in meeting both investigative demands and other regulatory obligations (e.g., Worker Protection Standard inspections, Certification and Training) to investigate dicamba complaints (AAPCO, 2020a). Dicamba issues have been routinely discussed at meetings (e.g, SFIREG; Trossbach, 2019) and members report that there is ‘dicamba fatigue’ from investigating the large number of incidents (Pucci, 2020; Unglesbee, 2019a; 2019b). Members have expressed concerns that their input on dicamba incidents does not make a difference, that EPA has not taken action in response to past reports, and for is a lack of resources (budget and personnel) to investigate all reported cases (AAPCO, 2020a; 2020b).

Breeding/Research Program Impacts

In the United States, 16 states have soybean breeding and genetics programs housed at their respective land grant institutions. The United States also employs seven soybean geneticists/breeders at United States Department of Agriculture Agricultural Research Service facilities across six states (Orf, 2015). These public soybean breeding programs differ in their goals and objectives compared to private soybean breeding programs. Public soybean breeding programs maintain a greater array of genetic diversity compared to private breeding programs. Public breeding programs utilize this array of genetic diversity to focus more production factors such as disease and insect resistance, abiotic stress tolerance, and seed quality components that can be overlooked by private companies that tend to focus on yield (Orf, 2015). Given that public breeding programs are not profit driven, they are able to take on longer term and more risky projects than their private counterparts (Sleper and Shannon, 2003; Tracy, 2015). Aside from

releasing conventionally bred varieties for commercial production, several of public soybean breeding programs also develop special purpose varieties for food use. These include varieties released for the production products such as tofu and soymilk. Growers of non-genetically modified soybean have the potential to receive higher premiums when selling their crop (Preiner, 2016). In addition to the development and release of commercial varieties, public breeding programs train and educate students in the areas of plant breeding and genetics that go on to work in both public and private plant breeding and research programs (Sleper and Shannon, 2003; Orf, 2015).

Offsite dicamba movement has been reported as negatively impacting both public and private plant breeding and research programs. In 2019, the University of Arkansas System Division of Agriculture reported the loss of 250 acres of experiments at the Northeast Research and Extension Center in Keiser which cost the university about \$500,000 (Breen, 2019). Crop damage appeared in the research plots even after the May 25th cutoff date for OTT dicamba applications in Arkansas (Breen, 2019). Similarly, extensive damage to soybean breeding programs was reported that the University of Missouri Fisher Delta Research Center in Portageville, Missouri (Charles, 2019). Soybean breeders there report extensive damage to their non-dicamba-tolerant breeding and research plots and indicate that data could not be collected and analyzed from the damaged plots. In 2019, soybean breeders at the University of Nebraska, Kansas State, and the University of Arkansas also reported damage to research and breeding plots (Charles, 2019). In addition to university soybean research and breeding programs, private seed companies, including Stine Seed and BASF, have reported offsite dicamba damage to their research and breeding programs (Charles, 2019). In 2020, The University of Arkansas System's Division of Agriculture reported damage to research and breeding programs at their research stations located in Keiser, Marianna, and Rower (Steed, 2020a). Most reports of damage to breeding programs have focused on soybean, likely due to their high sensitivity to dicamba.

In a survey of WSSA research organizations in 2019, AAPCO (2020c) reported that 53% of the organizations experienced damage to field trials and research due to offsite dicamba movement. Of those organizations reporting damage, 40% reported that the damage from offsite dicamba movement was due to particle drift at the time of application. Also, of the organizations reporting damage from offsite dicamba movement, 30% reported momentary losses due to the damage with one respondent reporting over \$250,000 worth of trials being negatively impacted by offsite dicamba movement (AAPCO, 2020c). Crop research organizations conducting field trials in corn and cotton that are not breeding or genetics trials (agronomic trials, crop protection trials, etc.) could potentially utilize dicamba tolerant varieties for these trials to protect them from offsite dicamba movement. However, crop breeding and genetics field trials utilizing germplasm without the dicamba tolerance trait may continue to be at risk for off-target dicamba damage.

University soybean breeders also report the commercial varieties that they release are not dicamba-tolerant. Charles (2019) suggests that growers are losing interest in varieties developed by universities because of the potential damage that could occur when planting non-DT soybean

varieties. The continual loss of university soybean breeding research could jeopardize the long-term viability of the university's breeding program. As noted earlier, university research programs often develop varieties that are based in conventional breeding / niche market (i.e., non-genetically modified) in which industry-based breeding programs may not invest.

Organic & Specialty Growers

For both specialty crop and organic growers, offsite movement of dicamba onto their property can result in a variety of potential consequences (Maynard et al. 2012).

Drift may cause yield or quality losses in the exposed crops. Many fruits and vegetables are sensitive to very low levels of dicamba. Growers of these crops, as well as other sensitive crops, have had extensive crop damage due to dicamba offsite movement (AAPCO, 2020b; SOCC, 2020). For perennial crops, damage may be compounded by exposures across multiple years.

Next, the dicamba residues may prevent crops or livestock as being marketed as organic. In order to be marketed as organic, regulations (7 CFR part 205.671) require residues to be less than 5% of the established tolerance on a commodity or 5% of the tolerance for indirect or inadvertent residues, if residues are found on a crop without a tolerance. Organic growers of field corn, popcorn, sugarcane, and especially sweet corn (tolerance = 0.04 PPM; residue could not exceed 2 PPB) could be more affected than growers of other crops. Since organic produce usually commands a premium price, the grower could suffer a substantial loss if the produce must be sold in the conventional market. The magnitude of the loss would depend on the specific commodity and the price differential received between organic and conventional production. No indirect or inadvertent tolerances have been established for dicamba (40 CFR § 180.227). Residue levels that exceed the established commodity tolerance, or if found on commodities without a tolerance, could be viewed as adulterated under the Federal Food, Drug, and Cosmetic Act and could be subject to seizure (U.S. Code Title 21. §334). A coalition of growers of specialty crops has voiced this concern to the Agency and requested tolerances be established to prevent potential losses (Save Our Crops Coalition, 2020).

Finally, it is possible that dicamba drift may cause the operation to lose organic certification, as dicamba is not on the National Organic Program list of allowed substances (7 CFR §205.601-606). It would take three years to be recertified as organic, during which the grower would lose the premium associated with organic certification.

Herbicide drift onto organic farms has occurred and has resulted in crop damage (Roseboro, 2018) in the past. The Agency is not aware of any verified, dicamba-specific impacts to organic crop growers from offsite movement, but this has happened in the case of other herbicides (Roseboro, 2018).

Other Impacts

Defensive Planting

Soybean and cotton, except for varieties modified for dicamba tolerance, are susceptible to injury if exposed to dicamba; soybean is generally more sensitive (Culpepper et al., 2017). One way for a grower to avoid damage due to drift or volatilization of dicamba from neighboring fields is to plant dicamba-tolerant varieties of soybean or cotton. This is referred to as ‘defensive planting’ e.g., growers planting dicamba-tolerant varieties of soybean not to use dicamba after crop emergence, but to protect their crops from the risk of exposure due to off-field movement of dicamba from neighboring fields. There are anecdotal reports of this occurring (AAPCO, 2020b; Nesse, 2020), but no systematic study to determine how common it may be. In the extreme, were defensive planting the norm, there could be concerns about companies providing DT technology to obtain monopoly power and extract excessive profits at the expense of growers.

Purchase of herbicide-tolerant seed does not necessarily imply that the grower intends to use the herbicide. Thus, lack of postemergence use of dicamba on dicamba-tolerant varieties does not necessarily imply that soybean growers are practicing defensive plantings. Growing an herbicide-tolerant variety gives the grower the option of using the herbicide if a weed problem emerges later in the season; the user may not need to apply the herbicide. Moreover, growers select seed not solely based on herbicide-tolerance traits but also other genetic attributes (e.g., drought tolerance, yield potential, adaptations to specific environments) that are bundled with herbicide tolerance traits. Some of these genetics may only be available with certain herbicide tolerant trait(s). Thus, individual growers may select a specific variety for certain desirable genetics, which happen to be accompanied with a trait for tolerance to an herbicide.

A comparison of herbicide usage across tolerant varieties may be informative. As shown in Table 10, 90% or more of the acreage planted with glyphosate or glufosinate tolerant varieties are treated with the respective herbicide after the crop has emerged. In contrast, only about half of the acreage planted with dicamba-tolerant varieties are subsequently treated with dicamba postemergence. Similarly, data collected and analyzed by USDA show approximately 60% of the acreage planted with dicamba-tolerant varieties are treated with dicamba, inclusive of applications prior to crop emergence (USDA, 2020a; see Appendix I). While this could suggest defensive planting, interpretation of the data is complicated by the fact that all dicamba-tolerant seed is also glyphosate tolerant. Thus, lack of dicamba usage may simply reflect the fact that, in addition to the genetics mentioned above, glyphosate tolerance remains a desirable trait. Glyphosate is the primary postemergence herbicide used in soybean, including in dicamba-tolerant soybean. Overall, over 90% of the acreage planted with the glyphosate + dicamba-tolerant varieties were treated with one or both of the herbicides, similar to the rates of other herbicide tolerant varieties.

Table 10. Proportion of HT Soybean Acres Treated Postemergence with Relevant Herbicide

Tolerance Trait	Acres Grown (millions)	% Acres Treated after Crop Emergence		
		Glyphosate	Dicamba	Glufosinate
Glyphosate ¹	40.4	90%	0	0
Dicamba + Glyphosate ¹	29.9	83%	51%	0
Glufosinate ¹	15.1	0	0	97%
Other ²	2.4	0	0	0

Source: Kynetec, 2019; 2017-2018 averages.

¹ Includes varieties that are also tolerant to sulfonylurea herbicides.

² Includes conventional varieties and varieties tolerant to sulfonylurea herbicides only.

A comparison of herbicide usage across tolerant varieties in cotton may provide additional information. Cotton is generally less susceptible to damage from off-field movement of dicamba than soybean (Culpepper et al., 2017) so the impetus for defensive planting may be lower. About 60% of dicamba-tolerant cotton is treated with dicamba postemergence (Table 11), implying about 40% is not, which is a somewhat lower rate than observed in soybean. As with soybean, data from USDA show a higher percentage, about 70% (USDA, 2020a; see Appendix I) of acres planted are treated with dicamba, but this estimate includes application prior to crop emergence. Dicamba tolerance is only available in conjunction with glyphosate and glufosinate tolerance and, again, glyphosate is the primary postemergence herbicide used by growers.

Table 11. Proportion of HT Cotton Acres Treated Postemergence with Relevant Herbicide

Tolerance Trait ¹	Acres Grown (millions)	% Acres Treated after Crop Emergence			
		Glyphosate	Dicamba	2,4-D	Glufosinate
Glyphosate ²	11.8	74%	36%	4%	22%
Glyphosate only	2.2	82%	0	0	12%
2,4-D + Glyphosate	0.7	82%	0	30%	71%
Glufosinate + Glyphosate	1.8	66%	0	0	46%
Dicamba + Glyphosate + Glufosinate	7.1	82%	60%	0	18%

Source: Kynetec, 2019; 2017-2018 averages.

¹ Traits are not mutually exclusive. Up to three traits for tolerance are available in a single variety.

² All herbicide tolerant varieties include glyphosate tolerance; remaining rows are subsets of these varieties.

³ All varieties with glufosinate tolerance, including those with glyphosate and with glyphosate and dicamba (see two subsequent lines).

The fact that some growers do not use dicamba postemergence on dicamba-tolerant soybean is not by itself evidence of defensive planting. However, the large proportion of dicamba-tolerant soybean that is not treated relative to other herbicide tolerant soybean varieties and to dicamba usage in dicamba-tolerant cotton, supports anecdotal reports (AAPCO, 2020b; Nesse, 2020) that some soybean growers may be planting dicamba-tolerant soybean as an insurance against off-field movement of dicamba from neighboring fields. If even three percent of the 29.9 million acres of dicamba-tolerant soybean (Table 10) were a result of defensive planting, it would represent almost one million acres of soybean. Defensive planting may also be occurring in cotton, but likely at a lower level than in soybean.

Dicamba-tolerant seed may be more expensive than other options or may require the grower to forego other desirable traits that force changes in production operation including the amount and type of fertilizer and the timing of production activities. Dicamba-tolerant seeds may not be available with genetics ideally suited to the grower's particular agronomic conditions, resulting in lower yields. Defensive planting could also increase other agronomic risks, such as risks from water stress, for example, if the use of dicamba-tolerant seed means foregoing traits for drought tolerance. The availability, or future availability, of these various other agronomic traits in dicamba-tolerant varieties is unknown. If defensive planting leads to the selection of a DT seed over more desirable seed varieties solely for protection from dicamba used by others, then there could be increased cost and/or reduced yields.

BEAD anticipates defensive planting will continue in the future regardless of the regulatory decision on the OTT products being considered. If the OTT dicamba products are registered, some soybean growers may continue to plant DT soybean defensively for fear that EPA's control measures will not eliminate the possibility of drift or volatilization (AAPCO, 2020b). Even if the OTT dicamba products are not registered, growers may continue to plant defensively because of the fear the potential for the misuse of non-OTT dicamba on DT crops. However, the limited level of such action and given the expanding number of competing herbicide tolerant options, means there is little to no ability for firms offering DT technology to exert monopoly power.

Social impacts

The potential for offsite injury to neighboring crops from dicamba can result in conflict between neighbors. Some examples of this conflict have been reported in the media. Injured parties may make reports to state authorities, as discussed in previous section(s). They may also sue for damages (Monsanto, 2017; Steed, 2020b). Both options require time, effort, and sometimes monetary costs to initiate and may or may not result in compensation for damages. Complaints and lawsuits may, in turn, spark or further escalate social impacts.

New technologies often can be controversial. Use of new technologies is sometimes viewed as a fairness issue because there are those who obtain advantages while others may perceive themselves to be disadvantaged. A recent study by James, et al. (2020) examined perceptions of the fairness of dicamba usage to growers in Missouri who did not use dicamba. The exploratory study involved only nine growers, seven who produced row crops and two who produced fruits

and vegetables. Results indicate that respondents rarely saw use of dicamba as “unfair.” However, it appears that most of the respondents found use of dicamba to be counter to their expectations of good grower behavior. Respondents indicated that growers should behave ethically, *i.e.*, consider how their actions affect others, and be knowledgeable of how to apply chemicals correctly. It may be that competing perceptions of what is ethical behavior drive the potential for conflict because dicamba users may believe that they have the right to control weeds in their fields without interference from neighboring growers.

The opportunity to employ new technologies also raises expectations among those who want to address problems in agriculture, e.g., glyphosate resistant weeds. Dicamba tolerant cotton and soybean were developed through genetic modification by Monsanto, now owned by Bayer. They were deregulated by USDA in 2015 (Firko, 2015a; 2015b). There was a limited commercial release in 2015 for cotton and 2016 soybean, prior to approval of dicamba for use after crop emergence, a situation described as a ‘train wreck’ by at least one extension specialist (Williams, 2016). Given the availability of dicamba-tolerant soybean and cotton and with the older, highly volatile dicamba products available, Jean Payne, president of the Illinois Fertilizer and Chemical Association, notes “If EPA does not allow over-the-top applications, there is the temptation to illegally apply off-label dicamba” (quoted in Gullickson, 2020). Use of older formulations of dicamba, not registered for postemergence use, was reported to registrants in 2015, two years before the first over the top products were registered (Carey, 2016).

Regardless of whether or not the Agency decides to register dicamba for DT crops, DT seed will be available and older formulations of dicamba will be on the market. If the Agency decides not to register dicamba for DT crops, there will still be significant market incentives to use dicamba for weed control after crop emergence, leading to the potential for illegal applications of other dicamba products not intended for use on DT crops.

Impacts to Non-Users of Dicamba from the Registration of OTT Dicamba Products

Incidents of plant damage consistent with exposure to dicamba have been documented in a variety of sensitive crops such as non-DT soybean, fruit trees, and vegetables. In 2016, dicamba applications resulted in incidents of off-target damage to sensitive non-DT soybeans and cotton, peaches, tomatoes, cantaloupes, watermelons, rice, cotton, peas, peanuts, alfalfa, residential gardens, and ornamental plantings (EPA, 2016c; Indiana Pesticide Review Board, 2017). The level of damage is variable and may range from slight leaf “cupping” to plant death. The level of damage depends on the magnitude and length of exposure, the number of times exposed, the growth stage of the affected plants when exposure occurs, and the response of the injured plant after exposure.

Quantification of this damage is difficult. There have been a few greenhouse studies that have attempted to follow plants with a known level of injury through maturity and harvest to quantify changes in yield or quality. These studies are currently insufficient to extrapolate to a field level to estimate an impact per acre of affected crop. Damage to plants in non-crop areas (e.g.,

shelterbelts, trees, residential plantings, etc.) usually lack an objective valuation that could be used to estimate overall damages.

Even though it is difficult to quantify, the damage can be bounded by examining the per-acre value of sensitive crops (USDA NASS, 2020c; calculated from yield per acre and value price per unit harvested). Soybean and cotton have a per-acre value of \$410 and \$510, respectively. Vegetable crops can have a value 10-fold higher (e.g., tomato, \$5,900 per acre). Perennial crops can have an even higher value (e.g., peaches, \$7,300 per acre). If the tree is no longer viable it would have to be replaced and the new tree would not be commercially productive for about four years. Damage to non-crop areas (shelterbelts, trees, residential plantings, etc.) is difficult to quantify.

Overall, the impacts to non-users from the registration of these OTT dicamba products will depend on how well the selected control measures address the offsite movement of dicamba or reduces the potential for damage, if offsite movement does occur. Some measures only address one type of offsite movement (e.g., volatility) while others may address both volatility and spray drift (e.g., buffers). The performance of these measures depends on the efficacy of each measure separately, as well as in combination with the other required measures.

For example, the calendar-based application restriction is intended to limit applications of OTT dicamba to earlier in the growing season when temperatures are cooler. This addresses offsite movement that may occur through volatility but will have limited effect on offsite movement resulting from spray drift. Additionally, if offsite movement does occur at this timing, there may be a reduced impact because sensitive plants may not yet be present in adjacent areas. If the number of incidents is reduced, state agencies will expend fewer resources.

These control measures should benefit non-users by addressing offsite movement. However, impacts to non-users of OTT dicamba products may still occur, if misuse occurs. Enhanced annual training may help reduce the prevalence of label non-compliance.

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APPENDIX I

Information from USDA, Economic Research Service Data on Soybean survey from 2017 and Cotton survey from 2018–

Table 1. Dicamba Products Applied to Dicamba-tolerant Soybean¹

National				Range of Treated Acres		Application Timing Percentages				
				Percent Applied:						
Pesticide Product Name	EPA Number	Weighted Sum of Treated Acres	Standard Deviation	5th Percentile of Treated Acre Reports	95th Percentile of Treated Acre Reports	Before Planting	At Planting	After Planting	Defoliation prior to harvest	Fields Reporting Pesticide Treatment
BAS 452 18H HERBICIDE	796900133	D*	D*	D*	D*	100.0%				1
DICAMBA DMA 2# AG	6633000277	992,553	221,474	1.5	103.9	33.3%	8.3%	58.3%		48
CLARITY HERBICIDE	796900137	121,819	46,750	2.5	61.8	77.8%		22.2%		9
RIFLE-D HERBICIDE	3470400869	D*	D*	D*	D*	100.0%				1
RIFLE HERBICIDE	3470400861	D*	D*	D*	D*	80.0%	20.0%			5
DISTINCT HERBICIDE	796900150	D*	D*	D*	D*	100.0%				1
NORTHSTAR HERBICIDE	10000923	D*	D*	D*	D*			100.0%		1
ALBAUGH DICAMBA DMA SALT	4275000040	D*	D*	D*	D*			100.0%		2
DICAMBA DMA 4# AG	6633000276	2,235,422	440,125	11.0	189.7	43.5%	4.3%	52.2%		46
BRASH	138100202	D*	D*	D*	D*	100.0%				2
BANVEL + 2,4-D	6633000287	681,990	402,058	40.0	259.6	87.5%		12.5%		8
BANVEL + ATRAZINE	6633000286	D*	D*	D*	D*			100.0%		1
STATUS HERBICIDE	796900242	D*	D*	D*	D*	100.0%				5
LATIGO	590500564	D*	D*	D*	D*	100.0%				4
HELENA VISION	590500576	D*	D*	D*	D*	100.0%				1
NUFARM KAMBAMASTER HERBICIDE	7136800034	D*	D*	D*	D*	100.0%				4
STRUT HERBICIDE	3470401043	D*	D*	D*	D*	100.0%				1
STERLING BLUE	138100248	435,659	123,065	3.3	73.8	100.0%				16
DICAMBA DGA 4SC	4275000209	1,861,135	375,700	4.7	148.3	29.9%	3.0%	67.2%		67
DICAMBA AG	8322200014	D*	D*	D*	D*			100.0%		1
THUNDERMASTER	4275000076	D*	D*	D*	D*			100.0%		5
CIMARRON MAX HERBICIDE	43201555	D*	D*	D*	D*	100.0%				1
SPITFIRE HERBICIDE	7136800109	D*	D*	D*	D*	100.0%				1
DUPONT FEXAPAN HERBICIDE	35200913	759,711	243,355	13.3	80.5	40.0%		60.0%		20
M1768 HERBICIDE	52400617	6,370,433	747,937	8.4	154.5	26.1%	3.7%	69.4%	0.7%	134
Engenia Herbicide	796900345	14,095,240	1,055,168	5.0	238.4	12.0%	5.6%	82.0%	0.4%	266
HM-1410 HERBICIDE (Extendamax)	590500597	D*	D*	D*	D*	100.0%	82.0%	0.4%		1
CANON DICAMBA HERBICIDE	6936100044	D*	D*	D*	D*	50.0%		50.0%		2
Dicamba DMA + 2,4-D DMA SL	8310000045	D*	D*	D*	D*	100.0%				1
ALLIGARE DICAMBA 4	8192700055	D*	D*	D*	D*	100.0%				1

Source: ¹ USDA, 2020a.

Treated Acres are defined as the acres that receive pesticide multiplied by the number of times the field received a pesticide application. If a farmer treats 70 acres twice with the same herbicide, the treated acres are calculated as 140 acres.

Table 2. Dicamba Products Applied to Dicamba-tolerant Cotton¹

National		Range of Treated Acres				Application Timing Percentages				
						Percent Applied:				Fields Reporting Pesticide Treatment
Pesticide Product Name	EPA Number	Weighted Sum of Treated Acres	Standard Deviation	5th Percentile of Treated Acre Reports	95th Percentile of Treated Acre Reports	Before Planting	At Planting	After Planting	Defoliation prior to harvest	
BAS 183 06H HERBICIDE	796900131	D*	D*	D*	D*		100%			3
DICAMBA DMA 2# AG	6633000277	1,485,231.00	722,211.00	10.9	254.5	30%	5%	65%		79
CLARITY HERBICIDE	796900137	21,816.00	13,611.00	2.5	142.9	80%		20%		5
RIFLE-D HERBICIDE	3470400869	D*	D*	D*	D*			100%		1
RIFLE HERBICIDE	3470400861	243,522.00	125,031.00	8.4	120.0	73%		18%	9%	11
DIABLO HERBICIDE	22800379	D*	D*	D*	D*	100%				1
STERLING	138100190	D*	D*	D*	D*			100%		1
ALBAUGH DICAMBA DMA SALT	4275000040	D*	D*	D*	D*		50%	50%		2
DICAMBA DMA 4# AG	6633000276	877,583.00	234,762.00	6.8	309.7	50%	3%	47%		61
HELENA OUTLAW	590500574	D*	D*	D*	D*			100%		1
CLASH SELECTIVE HERBICIDE	22800615	D*	D*	D*	D*	100%				1
LATIGO	590500564	D*	D*	D*	D*	100%				2
NUFARM KAMBAMASTER HERBICIDE	7136800034	D*	D*	D*	D*	67%			33%	3
STRUT HERBICIDE	3470401043	D*	D*	D*	D*	67%		33%		3
STERLING BLUE	138100248	D*	D*	D*	D*	67%		33%		3
DICAMBA DGA 4SC	4275000209	3,351,166.00	997,479.00	9.2	646.8	40%	8%	52%		115
ORACLE DICAMBA AGRICULTURAL HERBICIDE	9318200010	D*	D*	D*	D*			100%		1
STRIKE 3	1477400002	D*	D*	D*	D*	100%				2
DICAMBA 4 LB HERBICIDE	6633000425	D*	D*	D*	D*			100%		1
DUPONT FEXAPAN HERBICIDE	35200913	D*	D*	D*	D*			100%		2
M1768 HERBICIDE	52400617	1,868,887.00	478,428.00	11.2	326.3	4%	9%	86%		74
Engenia Herbicide	796900345	1,850,032.00	423,740.00	8.3	224.3	11%	4%	85%		138
HM-1410 HERBICIDE	590500597	D*	D*	D*	D*	100%				1
LAST CALL SELECTIVE HERBICIDE	22800719	D*	D*	D*	D*			100%		1
A21472 Plus VaporGrip Technology	10001623	D*	D*	D*	D*			100%		1

Source: ¹ USDA, 2020a

Treated Acres are defined as the acres that receive pesticide multiplied by the number of times the field received a pesticide application. If a farmer treats 70 acres twice with the same herbicide, the treated acres are calculated as 140 acres.

Table 3. Respondent Reports of Drift, Cupping, and Dicamba-tolerant Soybean Use ¹

All Fields	Herbicide Tolerance to Dicamba	Weighted Sum of Planted Acres	Standard Deviation
	No	49,149,106	1,623,637
	Yes	33,913,838	1,445,405

p1974 "Did you observe "cupping" or other symptoms associated with dicambadrift/volatility on the selected field in 2018? "

	Herbicide Tolerance to Dicamba	Frequency	Weighted Frequency	Standard Error of Weighted Frequency	Percent	Standard Error of Percent
No	No	1,337	1,054,835	34,634	63.51	1.39
	Yes	833	541,593	23,015	32.61	1.33
	Total	2,170	1,596,428	34,955	96.12	0.58
Yes	No	57	42,669	6,888	2.57	0.41
	Yes	26	21,828	6,851	1.31	0.41
	Total	83	64,497	9,672	3.88	0.58

Note: Question only asked if respondent answered "Yes" to p1974

p1975 "Do you believe that the damage you observed on the selected field in 2018 was due to drift (not volatility)?"

	Herbicide Tolerance to Dicamba	Frequency	Weighted Frequency	Standard Error of Weighted Frequency	Percent	Standard Error of Percent
No	No	11	10,143	4,052	15.92	5.97
	Yes	15	11,613	4,324	18.23	6.30
	Total	26	21,756	5,675	34.15	7.57
Yes	No	45	31,734	4,252	49.81	7.68
	Yes	11	10,214	5,105	16.03	7.20
	Total	56	41,948	6,011	65.85	7.57

Source: ¹ USDA, 2020a

Table 4. Respondent Reports of Drift, Cupping, and Dicamba-tolerant Soybean Use by Acres ¹

	Herbicide Tolerance to Dicamba	Weighted Sum of Planted Acres	Standard Deviation
All Fields	No	49,149,106	1,623,637
	Yes	33,913,838	1,445,405

p1974 "Did you observe "cupping" or other symptoms associated with dicambadrift/volatility on the selected field in 2018? "

	Herbicide Tolerance to Dicamba	Observations	Weighted Sum of Planted Acres	Standard Error of Sum	Lower 95% Confidence Limit for Sum	Upper 95% Confidence Limit for Sum
No	No	1,326	45,806,869	1,070,321	43,620,982	47,992,756
	Yes	833	32,900,530	1,121,608	30,609,901	35,191,159
	Total	2,160	78,715,364	824,276	77,031,968	80,398,759
Yes	No	57	3,204,881	578,885	2,022,640	4,387,122
	Yes	26	986,688	276,663	421,667	1,551,710
	Total	83	4,191,569	663,875	2,835,757	5,547,382

Note: Question only asked if respondent answered "Yes" to p1974

p1975 "Do you believe that the damage you observed on the selected field in 2018 was due to drift (not volatility)?"

	Herbicide Tolerance to Dicamba	Observations	Weighted Sum of Planted Acres	Standard Error of Sum	Lower 95% Confidence Limit for Sum	Upper 95% Confidence Limit for Sum
No	No	11	448,341	174,428	92,111	804,571
	Yes	15	659,386	246,298	156,378	1,162,393
	Total	26	1,107,727	299,847	495,358	1,720,096
Yes	No	45	2,743,457	571,351	1,576,602	3,910,312
	Yes	11	327,303	125,032	71,954	582,651
	Total	56	3,070,760	574,746	1,896,972	4,244,547

Source: ¹ USDA, 2020a

Table 5. Data for Acres of Dicamba Tolerant Soybean NOT Treated with Dicamba (for the Defensive Planting Section)

	Herbicide Tolerance to Dicamba	Weighted Sum of Planted Acres	Standard Deviation	Fields
All Fields	No	49,149,106	1,623,637	1,396
	Yes	33,913,838	1,445,405	860

Note: determining why there are reports of dicamba use on non DT soybeans is part of ongoing research. Currently, these reports are attributed to measurement error in the survey.

By Dicamba Application

	Herbicide Tolerance to Dicamba	Weighted Sum of Planted Acres	Standard Deviation	5th Percentile of Treated Acres	95th Percentile of Treated Acres	Fields
Fields Treated With Dicamba	No	2,531,666	422,176	3.31	124.92	66
	Yes	20,015,414	947,635	4.69	179.64	480

	Herbicide Tolerance to Dicamba	Weighted Sum of Planted Acres	Standard Deviation	5th Percentile of Treated Acres	95th Percentile of Treated Acres	Fields
Fields NOT Treated With Dicamba	No	46,617,440	1,498,863	3.56	149.75	1,330
	Yes	13,898,424	924,948	4.84	150.46	380

Table 6. Data for Acres of Dicamba Tolerant Cotton NOT Treated with Dicamba (for the Defensive Planting Section)

	Herbicide Tolerance to Dicamba	Weighted Sum of Planted Acres	Standard Deviation	Fields
All Fields	No	3,036,262	375,663	264
	Yes	6,667,828	637,170	499

Note: determining why there are reports of dicamba use on non DT soybeans is part of ongoing research. Currently, these reports are attributed to measurement error in the survey.

By Dicamba Application

	Herbicide Tolerance to Dicamba	Weighted Sum of Planted Acres	Standard Deviation	5th Percentile of Treated Acres	95th Percentile of Treated Acres	Fields
Fields Treated With Dicamba	No	567,494	134,907	2.50	127.58	51
	Yes	4,518,162	555,719	8.83	261.96	310

	Herbicide Tolerance to Dicamba	Weighted Sum of Planted Acres	Standard Deviation	5th Percentile of Treated Acres	95th Percentile of Treated Acres	Fields
Fields NOT Treated With Dicamba	No	2,468,768	345,128	6.17	214.91	213
	Yes	2,149,666	296,532	6.32	183.27	189